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RESEARCH ARTICLE

Sakarya et al: Procalcitonin in coronary syndromes

Procalcitonin in acute and chronic coronary syndromes: Diagnostic biomarker of coronary inflammation

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ABSTRACT

Procalcitonin (PCT) is classically a biomarker of bacterial infection, but its role in cardiovascular inflammation—particularly in coronary artery disease (CAD)—is less well defined. Evidence linking PCT with disease extent and outcomes across acute coronary syndrome (ACS) and chronic coronary syndrome (CCS) remains limited. We compared PCT levels among ACS, CCS, and angiographic controls; examined associations with inflammatory burden and anatomic complexity (SYNTAX score); and evaluated diagnostic performance and short- and intermediate-term prognostic value. In this single-center retrospective study, 477 consecutive adults undergoing diagnostic coronary angiography (December 2019–March 2020) were categorized as ACS (n=190), CCS (n=202), or controls with normal epicardial arteries (n=85). Demographic, laboratory, and angiographic data were collected. PCT was measured within 24 hours of admission. Multivariable logistic regression (using $\log_{10}$-transformed PCT) assessed independent associations with ACS and CCS. Correlations tested relationships with SYNTAX, C-reactive protein (CRP), and troponin-I. Receiver operating characteristic (ROC) analyses quantified discrimination. In ACS, outcomes were compared by PCT ≥0.25 ng/mL. Median PCT was higher in ACS and CCS than in controls (both p<0.001). Log_{10}-PCT independently predicted disease presence in ACS (OR 4.30, 95% CI 2.00–9.20, p<0.001) and CCS (OR 2.81, 95% CI 1.43–5.54, p=0.003). In CCS, PCT correlated weakly but significantly with SYNTAX score (r=0.274, p=0.002); no meaningful correlations with SYNTAX, CRP, or troponin-I were observed in ACS. PCT showed moderate diagnostic accuracy (AUC 0.791 for ACS; optimal cut-off 0.25 ng/mL, sensitivity 82.4%, specificity 65.3%; and AUC 0.763 for CCS; optimal cut-off 0.30 ng/mL, sensitivity 89.4%, specificity 54.0%; all p<0.001). In ACS, PCT ≥0.25 ng/mL was not associated with higher in-hospital mortality, 1-year all-cause mortality, or major adverse cardiovascular events. PCT reflects inflammatory burden and the presence of CAD in both ACS and CCS and remains an independent predictor of disease presence, but its prognostic utility—particularly in ACS—is limited. PCT should complement, not replace, established biomarkers and anatomical scoring systems in clinical decision-making. Prospective, multicenter studies with serial PCT measurements are warranted to refine its clinical role.

Keywords: Procalcitonin, coronary artery disease, acute coronary syndrome, chronic coronary syndrome, inflammation.

INTRODUCTION

Cardiovascular diseases (CVD) continue to be one of the leading causes of mortality and morbidity worldwide. Accounting for nearly half of all non-communicable diseases, this group represents a significant public health concern, projected to cause more than 17 million deaths annually by 2030 [1]. Among CVDs, coronary artery disease (CAD) holds particular importance due to both its high prevalence and its association with sudden cardiac events. CAD manifests in two major clinical forms: acute coronary syndrome (ACS) and chronic coronary syndrome (CCS). According to the 2023 and 2024 guidelines of the European Society of Cardiology, acute coronary syndrome refers to clinical presentations characterized by acute chest pain, dynamic electrocardiographic changes such as ST-segment elevation or depression, and elevated cardiac biomarkers, most notably high-sensitivity troponin. This category encompasses ST-elevation myocardial infarction, non-ST-elevation myocardial infarction, and unstable angina. In contrast, chronic coronary syndrome includes stable patterns of exertional or predictable chest pain without acute changes in electrocardiography or biomarker levels, and is typically diagnosed using clinical assessment and non-invasive or invasive imaging tests [2,3]. Although these clinical presentations follow different courses, they share a common underlying pathophysiological process: atherosclerosis [4].

Atherosclerosis is a chronic, progressive vascular disease characterized by lipid accumulation, endothelial dysfunction, immune system activation, and inflammatory responses. This process not only leads to luminal narrowing of the arteries but also predisposes to plaque instability and sudden thrombotic events. Therefore, in recent years, it has been emphasized that atherosclerosis should be regarded not merely as a lipid-driven pathology, but also as an inflammatory disease [5].

In clinical practice, various biomarkers are used to reflect inflammation. While markers such as C-reactive protein (CRP) and interleukin-6 (IL-6) have been widely studied in the atherosclerotic process, procalcitonin (PCT), a known marker of infection, has recently attracted attention in this context as well [6,7]. Under normal conditions, PCT is an inactive propeptide secreted by thyroid C cells and converted into calcitonin. However, in the presence of systemic inflammation, especially under the influence of bacterial endotoxins and proinflammatory cytokines (IL-1β, TNF-α, IL-6)—PCT is actively synthesized by many parenchymal organs (such as the liver, lungs, intestines, and the monocyte-macrophage system), resulting in a marked increase in serum levels [8].

The direct association of PCT with systemic inflammatory responses makes it a potential biomarker not only in infections but also in other conditions involving inflammation. Recent studies have shown that PCT levels may also rise in non-infectious conditions, particularly during cardiovascular events. In this regard, it has been suggested that PCT may reflect the inflammatory response and provide prognostic information in cases such as acute coronary syndrome, heart failure, and even some stable coronary syndromes [9,10]. This has led to the consideration of PCT as a potential "non-specific inflammatory biomarker" in atherosclerotic diseases.

However, studies investigating the relationship between PCT and different CAD subtypes such as ACS and CCS are limited and yield conflicting results. Moreover, the association between PCT levels and the angiographic extent or severity of the disease has not been clearly established. The SYNTAX (Synergy Between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery) score, developed to address this gap, is an important tool used to assess the anatomical complexity and extent of lesions in CAD and was used as a reference in this study [11].

This study aims to compare serum PCT levels among patients with ACS, CCS, and controls with angiographically normal epicardial coronary arteries; and if significant differences are identified, to explore the associations of these differences with disease extent and severity, as well as their relationship with prognosis in the ACS group. The ultimate goal is to obtain new and clearer insights into the role of PCT in the atherosclerotic process.

MATERIALS AND METHODS

Data collection

Study design

This study is a retrospective and observational clinical investigation conducted at the Department of Cardiology, Faculty of Medicine, Mersin University. Medical records and digital archives of patients who presented to the cardiology department with a preliminary diagnosis of coronary artery disease and underwent diagnostic coronary angiography between December 1, 2019, and March 15, 2020, were retrospectively reviewed. Although the study period coincided with the early phase of the COVID-19 pandemic, all data were collected before widespread national lockdowns and before significant reorganization of catheterization laboratory schedules. The study was conducted in a tertiary referral center

located in a metropolitan city with a population of over three million, serving as a regional hub for cardiovascular diagnostics and interventions. During the study period (December 1, 2019 to March 15, 2020; 106 days), a total of 510 diagnostic coronary angiograms were performed, corresponding to an average of approximately 4.8 procedures per day. Of these, 33 cases were excluded due to missing data, resulting in a final analytic cohort of 477 patients. Only those patients with complete clinical, laboratory, and imaging data at the time of admission were included in the study. Patients with missing clinical, laboratory, or imaging data were excluded from the analysis to minimize the risk of bias associated with incomplete datasets. Of the 510 patients initially screened, 33 were excluded due to missing data (14 with incomplete laboratory results, 11 with missing imaging data, and 8 with incomplete clinical records). The final cohort therefore comprised 477 patients (ACS = 190, CCS = 202, Control = 85). Baseline characteristics of excluded patients did not significantly differ in terms of age, sex distribution, or major cardiovascular risk factors compared to the included cohort, minimizing the likelihood of systematic bias. The dataset consisted of demographic information, medical history findings, laboratory results, and coronary angiography images collected at admission. No intervention was made in the treatment management of patients during the study period; data analysis was performed solely through the evaluation of existing records. To minimize potential selection bias due to the retrospective nature of the study, inclusion and exclusion criteria were predetermined and standardized. All data were obtained from the hospital information management system and archived digital angiography images, and the integrity of the records was verified by two independent investigators.

Data collection

A total of 477 patients were systematically evaluated according to the predefined inclusion and exclusion criteria. Individuals aged 18 years or older who underwent diagnostic coronary angiography due to suspected coronary artery disease and had complete clinical, laboratory, and imaging data at the time of hospital admission were included in the study. Patients with active infection, systemic inflammatory or autoimmune diseases, known malignancies, severe hepatic or renal dysfunction, recent major surgery or trauma within the past three months, use of immunosuppressive therapy, pregnancy, or incomplete data were excluded. Based on angiographic and clinical findings, patients were divided into three main groups. The first group, the acute coronary syndrome group, included patients diagnosed according to the relevant guidelines of the European Society of Cardiology for the management of acute

coronary syndromes. The second group, the chronic coronary syndrome group, included patients classified in line with the European Society of Cardiology guidelines for the diagnosis and management of chronic coronary syndromes. The third group, the control group, consisted of individuals presenting with similar symptoms but with completely normal epicardial coronary arteries on angiography. These symptoms predominantly included non-specific chest discomfort or exertional complaints, which initially led to a suspicion of either ACS or CCS but were ultimately not confirmed by angiographic or biochemical findings.

Demographic data (age, sex, body mass index), cardiovascular risk factors (hypertension, diabetes mellitus, dyslipidemia, active smoking, history of cerebrovascular disease), and symptom onset times were recorded for each patient. Laboratory data were obtained from samples taken within the first 24 hours following hospital admission. All blood samples, including those for procalcitonin, were obtained within the first 24 hours of hospital admission, typically prior to coronary angiography. The parameters evaluated included serum procalcitonin, CRP, troponin-I, hemoglobin, total leukocyte and platelet counts, total cholesterol, LDL-C, HDL-C, triglycerides, and glomerular filtration rate (GFR). All laboratory analyses were performed in the hospital's central laboratory using standard biochemical analyzers and manufacturer-recommended validation protocols. Serum procalcitonin levels were measured using high-sensitivity (hs-PCT) electrochemiluminescence immunoassay (ECLIA) kits (Elecsys BRAHMS PCT, Roche Diagnostics GmbH, Mannheim, Germany) on a Cobas e601 analyzer in the hospital’s central laboratory. The analytical limit of detection (LOD) was 0.02 ng/mL and the limit of quantitation (LOQ) was 0.06 ng/mL. The intra-assay and inter-assay coefficients of variation (CVs) were <6% and <8%, respectively, as reported by the manufacturer and verified in our laboratory. Blood samples were collected within the first 24 hours of admission, centrifuged at 3,000 rpm for 10 minutes, and the sera were analyzed immediately or stored at –80 °C until batch analysis. This ensured optimal stability and reproducibility of PCT measurements.

Coronary angiography was performed in all patients via the femoral or radial route using standard catheter techniques. The images obtained were retrospectively reviewed on the PACS system by two independent cardiologists experienced in coronary anatomy assessment. During this review, the SYNTAX score was calculated for each patient by considering the number of lesions, anatomical localization, bifurcation structure, and presence of calcification. When inter-rater agreement was ≥90%, the scores were averaged and included in the analysis; in cases of disagreement, a third senior cardiologist was consulted.

Data analysis

Statistical analysis

Initially, the distribution characteristics of continuous variables were assessed using the Kolmogorov–Smirnov test for normality and Levene's test for homogeneity of variances. Parametric tests, including one-way ANOVA, were applied only to variables that met both normality and homogeneity assumptions; otherwise, non-parametric alternatives such as the Kruskal–Wallis test were used. For variables with statistically significant differences, pairwise comparisons were performed using the post hoc Mann–Whitney U test. To control for multiple pairwise testing, a Bonferroni-adjusted significance threshold of $p < 0.017$ was applied, while the global significance level was set at $\alpha = 0.05$. Continuous variables were presented as mean ± standard deviation (SD) or median (interquartile range, IQR).

For categorical variables, frequencies and percentages were calculated, and comparisons among the three groups were made using the Pearson chi-square test. When more than 20% of expected cell frequencies were below 5, the Fisher's exact test was used instead.

In line with the primary objective of the study, two separate multivariate logistic regression analyses were conducted to evaluate the independent effect of PCT levels in predicting the presence of ACS and CCS. In the ACS model, patients with both ST-elevation myocardial infarction (STEMI, n = 112) and non-ST-elevation myocardial infarction (NSTEMI, n = 78) were included, while patients with unstable angina were not incorporated into the regression analysis. In these models, the dependent variables were defined as the presence of ACS and CCS, respectively. The independent variables included age, sex, body mass index (BMI), hypertension (HT), diabetes mellitus (DM), dyslipidemia (DL), smoking status, GFR, CRP, and PCT levels. Regression results were reported as odds ratios (OR) with 95% confidence intervals (CI) and p-values. Multicollinearity between variables in the multivariate models was assessed using variance inflation factor (VIF), with values <5 considered acceptable; all included variables had VIF values ranging from 1.2 to 2.8, indicating no concerning collinearity. Linearity in the logit for continuous predictors was evaluated using the Box–Tidwell test, with no significant deviations detected. Influential observations were further examined using standardized residuals and leverage values, and no cases exceeded commonly accepted cutoffs.

To evaluate the association between PCT levels and disease severity, correlation analyses were performed. These analyses examined the relationships between PCT and SYNTAX

score, CRP, and troponin-I levels. Depending on the distribution characteristics of the variables, either Pearson's correlation coefficient was used (if parametric assumptions were met), or Kendall's Tau-b correlation coefficient was used (for non-parametric data). For the association between PCT and SYNTAX score in the CCS group, Pearson's correlation was applied, as both variables met parametric assumptions. Correlation strength was classified as weak ($r < 0.3$), moderate ($r = 0.3–0.6$), or strong ($r > 0.6$) as commonly defined in the literature.

Additionally, patients in the ACS group were divided into two subgroups according to their serum PCT levels: PCT ≥0.25 ng/mL and PCT <0.25 ng/mL. These subgroups were compared in terms of in-hospital mortality, one-year all-cause mortality, and the frequency of major adverse cardiovascular events (MACE). For categorical outcome variables, the chi-square or, when necessary, the Fisher exact test was applied.

Software

All statistical analyses were performed using IBM SPSS Statistics for Windows Version 21.0 (IBM Corp., Armonk, NY, USA) and MedCalc Statistical Software Version 19.2.6 (MedCalc Software Ltd., Ostend, Belgium). A p-value of <0.05 was considered statistically significant. A post hoc power analysis was conducted using G*Power software. Based on the regression model (Nagelkerke $R^2 = 0.27$), the calculated power was 93.6% for detecting the predictor effect size at an alpha level of 0.05.

Ethical approval

Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of Mersin University Faculty of Medicine, with decision number 2020/346 dated April 29, 2020.

Declaration of Helsinki

The research process was conducted entirely in accordance with the ethical principles of the Declaration of Helsinki, published in 2013 by the World Medical Association, and all scientific procedures were carried out within this framework.

Informed written consent

Written informed consent was obtained from all individuals included in the study as part of standard clinical procedures at the time of hospitalization. This consent form explicitly covered both the treatment process and the analysis of data to be used in this study.

RESULTS

A total of 477 patients were included in this study and were classified into three groups based on angiographic findings: the acute coronary syndrome group (n = 190), the chronic coronary syndrome group (n = 202), and the control group (n = 85). Demographic characteristics, clinical risk factors, laboratory parameters, and angiographic scores were compared across the groups. Normality of distribution was assessed for continuous variables, and appropriate statistical tests were applied accordingly. Additionally, the relationship between PCT levels and clinical markers was evaluated using correlation analysis, and the prognostic value of PCT was analyzed in subgroups within the ACS cohort.

The data are presented below under the subheadings of demographic findings, laboratory parameters, correlation analyses, and multivariate logistic regression results.

Table 1 demonstrates that the mean age was highest in the ACS group (64.2 ± 10.8 years) and lowest in the control group (57.1 ± 13.3 years), with a statistically significant difference ($p < 0.001$). The proportion of male patients was significantly higher in the ACS (70.5%) and CCS (68.3%) groups compared to the control group (42.4%) ($p < 0.001$). LVEF was lower in the ACS group [median 50.0 (45.0–55.0)] compared to both CCS and control groups [median 60.0 (55.0–60.0) and 60.0 (55.0–62.5), respectively], with a significant difference ($p < 0.001$). WBC count was highest in the ACS group [median 9.1 (7.6–11.4)] and lowest in the control group [median 7.1 (5.5–8.0)] ($p < 0.001$). Platelet count was significantly different among groups, with higher values in the CCS group [median 249.0 (215.8–308.0)] ($p = 0.002$). GFR showed significant variation, being higher in the control group [median 97.5 (89.7–107.5)] compared to ACS and CCS groups ($p = 0.001$). HDL cholesterol was significantly lower in the ACS group [median 39.6 (34.0–46.2)] compared to controls [median 47.0 (39.8–54.0)] ($p < 0.001$). Triglyceride levels were highest in the CCS group [median 151.0 (99.8–211.0)] and differed significantly across groups ($p = 0.002$). Dyslipidemia was significantly more frequent in the CCS group (90.1%) compared to the control group ($p < 0.001$), while differences with the ACS group did not remain statistically significant after Bonferroni correction ($p = 0.034$ for ACS vs. control, $p = 0.058$ for ACS vs. CCS). PCT levels were significantly elevated in the ACS and CCS groups [median 0.320 (0.18–0.60) and 0.320 (0.17–0.52), respectively] compared to controls [median 0.160 (0.05–0.24)] ($p < 0.001$). Similarly, CRP levels were significantly higher in the ACS group [median 3.94 (1.65–8.70)] than in CCS and control groups ($p = 0.001$). Smoking was more prevalent in the ACS group (32.6%) compared to CCS (19.8%) and control (17.6%) groups ($p = 0.003$). Diabetes mellitus

was more common in the CCS group (44.5%) than in the control group ($p < 0.001$) and ACS group ($p = 0.003$). However, the difference between ACS and control groups ($p = 0.027$) did not reach statistical significance after Bonferroni correction. Finally, the SYNTAX score was significantly higher in the ACS group (18.5 ± 9.4) than in the CCS group (12.2 ± 8.2) ($p < 0.001$).

According to table 2 post hoc analysis results, age showed a statistically significant difference between the CCS and control groups ($p < 0.001$) and between the ACS and control groups ($p < 0.001$). Post-hoc analyses were conducted among the three groups: ACS ($n = 190$), CCS ($n = 202$), and control ($n = 85$), to identify the source of statistically significant differences. The proportion of male patients was significantly higher in both the CCS vs. control ($p < 0.001$) and ACS vs. control ($p < 0.001$) comparisons. LVEF was significantly lower in the ACS group compared to both the control and CCS groups ($p < 0.001$ for both comparisons). WBC count was significantly different among all pairwise comparisons (CCS vs. control, ACS vs. control, CCS vs. ACS; $p < 0.001$ for each). Platelet count was significantly higher in CCS compared to ACS ($p < 0.001$). GFR was higher in the control group compared to both CCS ($p < 0.001$) and ACS ($p = 0.001$). HDL cholesterol was significantly higher in the control group than both CCS ($p < 0.001$) and ACS ($p < 0.001$). Triglycerides were significantly higher in CCS than in ACS ($p < 0.001$). PCT levels were significantly elevated in CCS and ACS groups when compared to the control group ($p < 0.001$ for both comparisons). CRP was significantly higher in the ACS group [median 3.94 (1.65–8.70)] than in the control group ($p = 0.001$) and also significantly higher compared to the CCS group ($p = 0.002$; Bonferroni threshold 0.017). It should be noted that the upper quartile boundary for CRP in the CCS group was 58.85 mg/L, indicating a markedly right-skewed distribution with a heavy upper tail rather than just isolated outliers. All results were confirmed from original laboratory records. Since nonparametric statistical tests were used for group comparisons, these outliers did not compromise the robustness of the analyses. It is important to note that in the post hoc comparisons, a Bonferroni-adjusted significance threshold of $p < 0.017$ was applied due to multiple pairwise tests. Some findings, such as those with p-values marginally above this threshold (e.g., $p = 0.02$), were not considered statistically significant under this correction, although they may indicate a trend. Therefore, interpretations of these borderline results should be made with caution to avoid overestimating their clinical or statistical relevance. Smoking was more common in the ACS group compared to both control ($p = 0.001$) and CCS ($p = 0.004$). Diabetes mellitus was more

prevalent in CCS than in both the control ($p < 0.001$) and ACS groups ($p = 0.003$). Dyslipidemia was significantly more common in CCS compared to the control group ($p < 0.001$).

The data in **Table 3 show** that increasing age is significantly associated with a higher likelihood of chronic coronary syndrome (OR: 1.047, 95% CI: 1.01–1.08, $p = 0.008$). In this model, the following covariates were adjusted for: age, sex, body mass index (BMI), hypertension, diabetes mellitus, dyslipidemia, smoking status, glomerular filtration rate (GFR), C-reactive protein (CRP), and procalcitonin. Male sex also emerged as a strong predictor, with men being more than four times as likely to have CCS compared to women (OR: 4.284, 95% CI: 2.10–8.76, $p < 0.001$). Dyslipidemia was independently associated with CCS, increasing the odds more than threefold (OR: 3.471, 95% CI: 1.42–8.47, $p = 0.006$). Most notably, procalcitonin levels showed a statistically significant and independent association with CCS (OR: 2.81, 95% CI: 1.43–5.54, $p < 0.001$), suggesting that higher PCT levels were associated with nearly a threefold increase in the likelihood of chronic coronary syndrome. Other variables such as BMI, diabetes mellitus, hypertension, smoking, CRP, and GFR did not reach statistical significance in this model.

The results in **Table 4 indicate** that several variables are statistically significant independent predictors of acute coronary syndrome. The multivariate logistic regression model for ACS included adjustments for the same set of variables: age, sex, BMI, hypertension, diabetes mellitus, dyslipidemia, smoking, GFR, CRP, and procalcitonin. Increasing age was strongly associated with ACS risk (OR: 1.108, 95% CI: 1.06–1.15, $p < 0.001$). Male sex exhibited a particularly high odds ratio, with men being more than seven times as likely to present with ACS compared to women (OR: 7.498, 95% CI: 3.10–18.16, $p < 0.001$). Diabetes mellitus was also significantly associated with ACS (OR: 3.207, 95% CI: 1.29–7.99, $p = 0.012$). Smoking increased the risk more than fourfold (OR: 4.124, 95% CI: 1.58–10.73, $p = 0.004$), while dyslipidemia showed a threefold increase in risk (OR: 3.444, 95% CI: 1.34–8.86, $p = 0.010$). Elevated C-reactive protein levels were associated with higher odds of ACS (OR: 1.112, 95% CI: 1.02–1.21, $p = 0.011$). Notably, procalcitonin also emerged as a strong and independent predictor of acute coronary syndrome (OR: 4.30, 95% CI: 2.00–9.20, $p < 0.001$), reflecting a more than fourfold increase in ACS risk with rising PCT levels.

The data in **Table 5 demonstrate** that procalcitonin PCT showed good discriminatory ability in differentiating both CCS and ACS from control patients. In the CCS group, the PCT level

had a sensitivity of 89.4% and a specificity of 54.0%, with an AUC of 0.763 and a statistically significant p-value of <0.001. For the ACS group, the sensitivity was slightly lower at 82.4%, while specificity increased to 65.3%. The AUC in this group was 0.791, with a p-value also <0.001. The optimal cut-off value for PCT was determined to be 0.30 ng/mL for CCS and 0.25 ng/mL for ACS. Therefore, in subgroup analyses, patients with PCT levels ≥0.25 ng/mL were considered to be in the elevated PCT group. These results suggest that PCT may serve as a moderately accurate biomarker for distinguishing both chronic and acute coronary syndromes from patients without angiographic evidence of coronary artery disease.

Table **6 presents** the in-hospital and one-year clinical outcomes of patients diagnosed with ACS, grouped according to their PCT levels. Patients with a PCT level ≥0.25 ng/mL had an in-hospital mortality rate of 1.6%, which was identical to those with PCT <0.25 ng/mL. The one-year all-cause mortality was 7.0% in the high PCT group and 8.2% in the low PCT group. Additionally, the one-year MACE rate was 9.3% in the elevated PCT group and 11.5% in the lower group. No statistically significant differences were observed between the two groups in any of the outcome measures.

DISCUSSION

Coronary artery disease, in both its acute and chronic forms, remains one of the leading causes of morbidity and mortality worldwide. It is now well established that inflammation plays a central role in the development of cardiovascular events, and the degree and duration of the inflammatory response directly affect the clinical picture and prognosis [12,13]. In this context, investigating the diagnostic and prognostic role of inflammatory markers is a critical area with potential to guide clinical management. This study aimed to compare PCT (procalcitonin) levels in patients with acute and chronic coronary syndromes, to evaluate the relationship of these levels with clinical and angiographic parameters, and to determine their predictive value.

In our study, 477 patients were analyzed and categorized into three groups: ACS, CCS, and control. Our findings revealed that serum PCT levels were significantly elevated in both ACS and CCS patients; however, there was no significant difference between the two disease groups. Additionally, PCT levels in the CCS group showed a weak but statistically significant correlation with the SYNTAX score. In contrast, no significant relationship was found in the ACS group between PCT levels and the SYNTAX score, CRP, or troponin-I.

Procalcitonin is a biomarker known for its elevation in bacterial infections. However, increased PCT levels have also been observed in systemic inflammatory processes unrelated to infection [10]. The pathophysiology of non-infectious PCT elevation has been described, particularly through hypoxic stress, endothelial damage, cytokine release, and neural stress [14]. In cardiac diseases, these mechanisms are activated during myocardial ischemia and reperfusion. Pro-inflammatory cytokines such as IL-6 and TNF-α directly increase PCT expression, and this process can occur even in the absence of infection [15,16].

From this perspective, PCT may reflect not only infection but also cardiovascular inflammation. For example, in a 2021 study by Sharma et al. on patients with ST-elevation myocardial infarction, PCT levels were significantly elevated, particularly in cases complicated by cardiogenic shock, and this increase was found to be significantly associated with prognosis [17]. Similarly, in a 2022 prospective study by Pavasini et al., although PCT was not found to be as strong a prognostic marker as CRP or IL-6 in ACS patients, its levels were significantly higher in high-risk patients [18]. Consistent with these findings, our study also showed significantly elevated PCT levels in ACS patients compared to controls; however, the absence of a correlation with SYNTAX score, troponin-I, or CRP suggests that in acute coronary events, PCT may reflect systemic inflammatory response rather than disease severity.

Nonetheless, some studies have reported more pronounced findings. In a 2022 study by Hu et al., high PCT levels were associated with 30-day mortality in ACS patients. Similarly, a 2019 study by Clementi et al. reported a significant association between elevated procalcitonin levels and in-hospital mortality in patients undergoing cardiac surgery [6,19]. In line with these, a 2024 prospective observational study by Hassan et al. demonstrated that plasma PCT levels in patients with acute ST-elevation MI were significantly associated with the occurrence of major adverse cardiovascular events (MACE), and that elevated levels could predict poor prognosis in the early period [20]. In these studies, a PCT threshold of ≥0.25 ng/mL was generally used, and levels above this were emphasized to have clinical significance.

In our study, the ACS group was similarly divided into two subgroups based on a PCT cut-off of 0.25 ng/mL. However, no significant difference was found between the subgroups in terms of mortality and MACE. However, it should be emphasized that the number of outcome events in our cohort—particularly in-hospital and one-year mortality—was

relatively low (3 and 14 cases, respectively). Due to the low number of in-hospital and one-year deaths, no multivariable regression models for mortality or MACE were fitted. Instead, only categorical comparisons (Chi-square/Fisher's exact test) were performed as shown in Table 6, which limits the ability to draw firm prognostic conclusions. According to widely accepted methodological standards, logistic regression analysis requires approximately 10 outcome events per predictor variable to ensure statistical reliability. In our cohort, the limited number of outcome events did not meet this requirement; therefore, outcome modeling was not performed to avoid generating misleading or unstable estimates. This suggests that the prognostic value of PCT in ACS may be influenced by various factors such as disease severity, time of presentation, comorbid conditions, hemodynamic instability, concomitant infection, or systemic inflammation. Additionally, the overall low event rate in our cohort may have limited the statistical power to detect significant differences in clinical outcomes based on PCT levels. Moreover, as shown in some studies, the prognostic power of PCT may only become meaningful in ACS cases complicated by sepsis or concurrent infection [21,22].

The finding obtained in the CCS group, on the other hand, is a less frequently explored but increasingly important topic. It has been shown that systemic inflammation persists at low levels in patients with stable angina pectoris and plays a role in the progression of atherosclerotic plaques [23]. In a study by Alavi et al. utilizing advanced PET imaging techniques, inflammatory cell infiltration (e.g., T cells and macrophages) was demonstrated even in stable atherosclerotic lesions, and these infiltrates were found to correlate with systemic inflammatory activity [24]. The modest but statistically significant correlation identified between PCT and SYNTAX score in our CCS group may partially reflect systemic inflammatory activity associated with anatomical disease burden. However, the same association was not observed in the ACS group, possibly due to the more dynamic and time-sensitive nature of inflammation in acute events, which may not directly reflect anatomical burden as captured by the SYNTAX score. Especially in multivariate analyses, both dyslipidemia and elevated PCT levels were found to be significantly associated with disease presence in the CCS group. The identification of PCT as an independent predictor in CCS suggests that this biomarker may reflect the inflammatory burden not only in acute but also in chronic coronary syndromes. Each increase in PCT level was observed to markedly raise the probability of disease. This finding is consistent with limited literature highlighting the role of systemic inflammation in chronic coronary syndrome.

The association between PCT and the SYNTAX score has been evaluated by only a few studies. In a 2017 study by Ertem et al. on patients with acute coronary syndrome, a significant positive correlation was observed between serum PCT levels and the SYNTAX score, indicating that PCT may reflect the severity and complexity of coronary artery disease [25]. This supports our finding in the CCS group. The observation that each incremental rise in PCT was associated with a moderate increase in disease likelihood represents an interesting finding that deserves further investigation. In the ACS group analysis, variables such as age, male sex, diabetes mellitus, smoking, dyslipidemia, and CRP were significantly associated with disease presence, with PCT levels emerging as particularly impactful. Notably, a serum PCT concentration of ≥0.25 ng/mL was associated with the presence of ACS in this cohort. ROC analysis also supported these findings, identifying 0.25 ng/mL and 0.30 ng/mL as optimal cut-off values for ACS and CCS, respectively, with AUC values of 0.791 and 0.763. These data suggest that PCT may serve not only as a marker of inflammatory burden but also as a supportive biomarker in the diagnosis of CCS and ACS. However, in our study, this relationship was not observed in the ACS group, possibly indicating that PCT levels in the acute phase reflect the temporal stage of systemic inflammation rather than disease burden.

CRP is one of the most commonly used inflammatory markers in the context of cardiovascular diseases. However, since CRP is of hepatic origin and rises later, it may be limited in identifying and stratifying early acute inflammation. In contrast, PCT rises within a few hours and has a half-life of 20–24 hours [26]. This characteristic makes it valuable in the early inflammatory response. However, its higher cost compared to CRP restricts its routine use. The absence of a significant correlation between PCT and CRP in the ACS group in our study also supports the notion that these two markers reflect different biological windows.

Another noteworthy finding is the lack of correlation between PCT and troponin-I levels. While troponin directly indicates myocardial cell injury, PCT reflects systemic inflammation. Therefore, the dissociation between these markers suggests that PCT is more sensitive to inflammatory response than to myocardial necrosis [27]. In our study, no significant correlation was found between PCT and troponin-I levels, reinforcing the idea that PCT is more closely linked to inflammation-based processes than to myocardial damage.

One of the strengths of our study is the evaluation of PCT levels in a patient population in which infectious causes were excluded. This allowed for a clearer assessment of the role of

PCT in non-infectious cardiac events. However, it should be noted that the control group, although free of angiographically evident coronary artery disease, included individuals with common cardiovascular risk factors such as dyslipidemia and hypertension. While these patients did not have overt CAD, they may still represent a population with potential subclinical atherosclerosis. This characteristic should be taken into account when interpreting intergroup differences, as it might have influenced the observed levels of inflammatory biomarkers such as procalcitonin. Additionally, the relatively large sample size and the use of multivariate analyses to control for confounding factors enhance the scientific validity of our study.

This study demonstrates that PCT levels are significantly elevated in both acute and chronic coronary syndromes and are modestly associated with disease extent in CCS. Compared to other biomarkers such as CRP and troponin, PCT reflects distinct biological pathways and offers diagnostic or differential value. This is supported by ROC analysis results, which indicated moderate diagnostic power. These results highlight the potential utility of PCT as a moderate diagnostic tool, especially when rapid decision-making is required and other inflammatory markers are unavailable or delayed. The cut-off values were determined to be 0.25 ng/mL for ACS and 0.30 ng/mL for CCS, and patients with PCT ≥0.25 ng/mL were classified into the elevated ACS subgroup, consistent with the subgroup analyses and Table 5. These findings suggest that PCT may play a supportive role in diagnosis.

However, the role of PCT in predicting cardiovascular prognosis remains controversial, and it is far from being a standalone determinant in clinical decision-making. Nonetheless, in multivariate logistic regression analysis of the ACS group, age, male sex, diabetes, smoking, dyslipidemia, CRP, and PCT levels were significantly associated with disease presence. This suggests that PCT may be useful not only for reflecting inflammation but also for identifying high-risk patient profiles. Procalcitonin emerged as a significant predictor of ACS, with an adjusted odds ratio of 4.30 (95% CI: 2.00–9.20), reflecting a meaningful increase in risk with rising PCT levels. Therefore, PCT should be utilized within a multidisciplinary framework alongside other inflammatory and cardiac biomarkers.

Limitations of the study

The findings of this study should be interpreted with caution due to several methodological and structural limitations. First and foremost, the retrospective and single-center design of the study represents a major limitation. Due to its retrospective and observational design, the

study cannot establish causal relationships between elevated PCT levels and clinical outcomes or disease presence; the findings should be interpreted as associative rather than causative. Since data were obtained from archived records, prospective control over clinical variables was not possible, and some potential confounding factors may have been overlooked. Additionally, as the study population was drawn from a single hospital, the demographic and clinical characteristics of the sample may reflect a limited population, thereby restricting the generalizability of the findings.

Second, PCT levels were measured only at the time of admission, and temporal changes were not monitored. However, the kinetic variation of inflammatory markers over time, particularly in dynamic conditions such as ACS, could provide valuable clinical insights. Serial monitoring of PCT levels could have more clearly revealed its prognostic role and its relationship with clinical course.

Third, although in-hospital and 1-year mortality and MACE were reported, these outcomes were analyzed only with univariate categorical tests and the number of events was low, making the analyses underpowered. Therefore, our study cannot provide definitive conclusions regarding the prognostic role of PCT. Therefore, the evaluation of PCT was limited to its values at admission, and its long-term prognostic value could not be analyzed. This limitation prevented a comprehensive assessment of PCT's potential contribution to clinical follow-up and risk stratification.

Fourth, certain systemic conditions that may cause elevation of PCT unrelated to infection (e.g., trauma, autoimmune diseases, or subclinical infections) may not have been entirely excluded. Despite careful exclusion of patients with overt infections, it is possible that subclinical or undiagnosed inflammatory conditions may have influenced PCT levels, which represents a potential confounding factor. Although clinical records and laboratory findings were carefully reviewed, achieving complete specificity for a parameter as sensitive as PCT to various biological stimuli is not always feasible in a retrospective study design.

Fifth, only a single inflammatory biomarker (PCT) was evaluated in our study, and no comparative analysis was conducted with other important biomarkers (e.g., IL-6, pro-BNP, presepsin, or hs-CRP). However, evaluating multiple biomarkers together could have provided a more comprehensive picture of the inflammatory process and enhanced diagnostic accuracy. In addition, the ROC-derived cut-off values reported in this study should be interpreted as exploratory, as no internal validation (e.g., bootstrapping or cross-validation) or

external validation was performed, and no formal calibration assessment (e.g., Hosmer–Lemeshow test) was conducted. Therefore, these cut-offs may be optimistic and require confirmation in independent cohorts.

Finally, the patients' medical treatments (e.g., statin use, ACE inhibitors, antibiotics) were not thoroughly controlled for in the study. Some medications are known to affect levels of inflammatory markers. When such variables are not accounted for, the measured levels of sensitive parameters like PCT may be influenced by treatment effects, potentially leading to biased results.

Despite all these limitations, this study is one of the rare investigations evaluating PCT in both acute and chronic coronary syndrome patients and contributes new and meaningful insights to the existing literature. Nonetheless, to obtain more robust conclusions, prospective, multicenter studies involving larger patient populations are necessary.

CONCLUSION

In this study, it was demonstrated that PCT levels were significantly elevated in both ACS and CCS patients compared to controls with angiographically normal epicardial coronary arteries. In both patient groups, elevated PCT levels reflected the presence of systemic inflammation. However, in the ACS group, PCT levels did not show a significant relationship with disease extent (SYNTAX score), myocardial injury (troponin-I), or CRP levels. In contrast, a weak but positive correlation was identified between PCT and the SYNTAX score in the CCS group. In multivariate logistic regression analyses, PCT was identified as an independent predictor for both types of coronary syndromes. These findings suggest that PCT may serve as a biomarker reflecting not only infectious conditions but also inflammation related to atherosclerotic processes.

Nevertheless, the prognostic value of PCT was found to be limited, and it may not be sufficient as a standalone parameter in clinical decision-making. Particularly in ACS patients, PCT levels exceeding the threshold of ≥0.25 ng/mL did not significantly predict prognosis. Therefore, PCT should be interpreted within an integrated framework that includes other biomarkers and anatomical scoring systems. In this context, the routine clinical use of PCT as a standalone biomarker in CAD evaluation is not currently supported, and its implementation should be considered only as part of a broader diagnostic algorithm. Given its potential to reflect inflammatory response, PCT may serve as a useful biochemical indicator in evaluating inflammatory activity, especially in relatively silent conditions such as CCS. However, this

suggestion requires further support from prospective, multicenter studies with larger sample sizes.

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REFERENCES

[1] Bilgiç A, Toprak B, Kaya H. Delta Neutrophil Index in Coronary Artery Bypass Surgery: An Innovation in Postoperative Mortality Assessment. J Inflamm Res. 2025;1497-1508.

[2] Byrne RA, Rossello X, Ludman PF, Katus HA, De Caterina R, Lettino M, et al. 2023 ESC Guidelines for the management of acute coronary syndromes. Eur Heart J. 2023;44(38):3621–3726.

[3] Picano E, Ciampi Q, Cortigiani L, Bossone E, Cameli M, D'Andrea A, et al. The clinical use of stress echocardiography in chronic coronary syndromes and beyond coronary artery disease: a clinical consensus statement from the European Association of Cardiovascular Imaging of the ESC. Eur Heart J Cardiovasc Imaging. 2024;25(2):e65–e90.

[4] Kern A, Schwarz W, Pfeifer B, Kienbacher C, Binder C, Neubauer M, et al. Comparative Ten-Year Outcomes in Chronic and Acute Coronary Syndrome Patients Undergoing Invasive Diagnostics—Insights from the KORONEF Registry. Biomedicines. 2024;12(12):2672.

[5] Attiq A, Jalil J, Husain K, Ahmad W, Rauf A, Muhammad N, et al. Hegemony of inflammation in atherosclerosis and coronary artery disease. Eur J Pharmacol. 2024;966:176338.

[6] Hu J, Zhang M, Huang L, Wang Y, Zhou S, Wang H, et al. Effects of atorvastatin doses on serum level of procalcitonin and predictors for major adverse cardiovascular events in patients with acute coronary syndrome: a pilot study and post hoc analysis. Coron Artery Dis. 2022;33(1):e87-e93.

[7] Yu L, Sun J, Liu X. Serum C reactive protein and procalcitonin are valuable predictors of coronary heart disease and poor prognosis in the elderly. Am J Transl Res. 2023;15(6):4188.

[8] Nan X. Prognostic value of inflammatory cytokine levels (TNF-α, procalcitonin, interferon gamma, IL-2, IL-6, and IL-10), clinical efficacy, and prognosis of hybrid artificial liver support system in the treatment of chronic liver failure. J Med Biochem. 2025.

[9] Li Y, Cui H, Chen B. Efficacy of NT-proBNP, hs-CRP, DD, and PCT in predicting heart failure after acute myocardial infarction based on ROC and DCA curve analysis. Int J Lab Med. 2024;686-691.

[10] Li J, Zhang Y, Chen L, Liu F, Ma Y, Zhou Q, et al. A review of novel cardiac biomarkers in acute or chronic cardiovascular diseases: the role of soluble ST2, lipoprotein-associated phospholipase A2, myeloperoxidase, and procalcitonin. Dis Markers. 2021;2021:6258865.

[11] Abbasi A, Salehi M, Rahimi M, Gholami M, Afshar M, Taghavi S. The potential role of serum procalcitonin and coronary angiographic findings in patients with acute coronary syndromes evaluated by the SYNTAX score. Iran Heart J. 2023;24(3):77-84.

[12] Soehnlein O, Libby P. Targeting inflammation in atherosclerosis—from experimental insights to the clinic. Nat Rev Drug Discov. 2021;20(8):589-610.

[13] Kong P, Cui Z, Huang Y, Gao J, Pan T, Wang Y. Inflammation and atherosclerosis: signaling pathways and therapeutic intervention. Signal Transduct Target Ther. 2022;7(1):131.

[14] Mućka S, Jakubiak GK, Pawlas N. Procalcitonin: infection or maybe something more? Noninfectious causes of increased serum procalcitonin concentration: updated knowledge. Life (Basel). 2025;15(3):446.

[15] Baranowsky A, Koch S, Reutelingsperger C, Vollmar B, Buerkle H, von Aulock S. Procalcitonin exerts a mediator role in septic shock through the calcitonin gene-related peptide receptor. Crit Care Med. 2021;49(1):e41-e52.

[16] Palalıoğlu B, Yücel D, Şimşek M, Aktaş A, Koç G. Diagnostic and prognostic value of pentraxin 3, interleukin-6, CRP, and procalcitonin levels in patients with sepsis and septic shock. Niger J Clin Pract. 2024;27(3):317-324.

[17] Sharma YP, Yadav S, Agarwal R, Soni S, Gupta A. Prognostic role of procalcitonin in ST-elevation myocardial infarction complicated by cardiogenic shock. Asian Cardiovasc Thorac Ann. 2021;29(8):751-757.

[18] Pavasini R, D'Ascenzo F, Campo G, Biscaglia S, Ferri A, Contoli M, et al. Procalcitonin predicts bacterial infection, but not long-term occurrence of adverse events in patients with acute coronary syndrome. J Clin Med. 2022;11(3):554.

[19] Clementi A, D'Amico G, Cefalù AB, Piraino D, Di Gaudio F, Rini GB, et al. Presepsin and procalcitonin levels as markers of adverse postoperative complications and mortality in cardiac surgery patients. Blood Purif. 2019;47(1-3):140-148.

[20] Hassan MM, Rahman MM, Alam MS, Kabir MA, Akhter S, Hossain MA. Association between plasma procalcitonin with onset of MACE in patients with acute ST elevated MI: a unicentric prospective observational comparative study. Univ Heart J. 2024;20(2):67-71.

[21] Fabbri G, Rossi A, Ferrari F, Bianchi M, Mancini C, Bartoli L, et al. Procalcitonin predicts bacterial infection, but not long-term occurrence of adverse events in patients with acute coronary syndrome. Eur Heart J Suppl. 2022;24(Suppl_C):suac012-191.

[22] Lyngbakken MN, Røsjø H, Omland T, Dalen H, Haugnes HS, Aukrust P, et al. Novel biomarkers of cardiovascular disease: applications in clinical practice. Crit Rev Clin Lab Sci. 2019;56(1):33-60.

[23] Arnold N, Schmidt K, Zeller T, Blankenberg S, Panayiotou A, Iacoviello L, et al. C-reactive protein modifies lipoprotein (a)-related risk for coronary heart disease: the BiomarCaRE project. Eur Heart J. 2024;45(12):1043-1054.

[24] Alavi A, Werner TJ, Høilund-Carlsen PF, Sadeghi MM, Zhuang H, Houshmand S. Critical review of PET imaging for detection and characterization of the atherosclerotic plaques with emphasis on limitations of FDG-PET compared to NaF-PET in this setting. Am J Nucl Med Mol Imaging. 2021;11(5):337.

[25] Ertem AG, Kaya A, İkitimur B, Akyüz A, Aydın M, Çelik T, et al. The association between serum procalcitonin levels and severity of coronary artery disease assessed by SYNTAX score in patients with acute coronary syndrome. Angiology. 2017;68(1):40-45.

[26] Reindl M, Reinstadler SJ, Feistritzer HJ, Tiller C, Ojeda FM, Metzler B, et al. Association of myocardial injury with serum procalcitonin levels in patients with ST-elevation myocardial infarction. JAMA Netw Open. 2020;3(6):e207030.

[27] Hartikainen TS, Siegbahn A, Nieminen MS, Vartiainen E, Salomaa V, Vähätalo J, et al. Clinical application of the 4th Universal Definition of Myocardial Infarction. Eur Heart J. 2020;41(23):2209-2216.

TABLES WITH LEGENDS

Table 1. Comparison of demographic, clinical, and laboratory parameters among ACS, CCS, and control groups (*n*=477)

Variable	ACS group (*n* = 190)	CCS group (*n* = 202)	Control group (*n* = 85)	*p* value
Age (years)	64.2 ± 10.8	62.4 ± 9.3	57.1 ± 13.3	**<0.001**
Male sex, *n* (%)	134 (70.5%)	138 (68.3%)	36 (42.4%)	**<0.001**
Systolic blood pressure (mmHg)	131.8 ± 20.4	133.7 ± 17.3	128.0 ± 15.2	0.062
Diastolic blood pressure (mmHg)	76.0 (70.0–81.5)	78.0 (72.0–84.3)	77.0 (71.0–89.0)	0.143
LVEF (%)	50.0 (45.0–55.0)	60.0 (55.0–60.0)	60.0 (55.0–62.5)	**<0.001**
WBC (×10³/mL)	9.1 (7.6–11.4)	8.0 (6.7–9.4)	7.1 (5.5–8.0)	**<0.001**
Platelet count (×10³/mL)	240.0 (188.3–275.0)	249.0 (215.8–308.0)	246.0 (202.5–295.5)	**0.002**
Hemoglobin (g/dL)	13.45 (11.9–15.05)	13.8 (12.2–14.7)	13.3 (11.6–14.5)	0.128
GFR (mL/min/1.73m²)	92.4 (75.1–102.0)	91.9 (73.3–101.0)	97.5 (89.7–107.5)	**0.001**
Total cholesterol (mg/dL)	185.8 ± 47.8	189.9 ± 52.5	200.0 ± 44.9	0.088
LDL cholesterol (mg/dL)	117.4 ± 40.4	114.9 ± 46.2	121.3 ± 36.9	0.231
HDL cholesterol (mg/dL)	39.6 (34.0–46.2)	40.6 (34.8–46.7)	47.0 (39.8–54.0)	**<0.001**
Triglycerides (mg/dL)	123.0 (80.0–177.3)	151.0 (99.8–211.0)	130.0 (94.0–168.0)	**0.002**
PCT (ng/mL)	0.320 (0.18–0.60)	0.320 (0.17–0.52)	0.160 (0.05–0.24)	**<0.001**

Variable	ACS group (*n* = 190)	CCS group (*n* = 202)	Control group (*n* = 85)	*p* value
CRP (mg/L)	3.94 (1.65–8.70)	2.74 (1.25–58.85)	2.40 (1.0–5.0)	**0.001**
BMI (kg/m²)	27.1 (25.4–31.1)	27.5 (24.9–31.2)	26.8 (24.6–30.3)	0.197
Smoking, *n* (%)	62 (32.6%)	40 (19.8%)	15 (17.6%)	**0.003**
Hypertension, *n* (%)	103 (54.2%)	128 (63.4%)	42 (49.4%)	0.057
History of cerebrovascular disease, *n* (%)	4 (2.1%)	5 (2.5%)	2 (2.4%)	0.982
Diabetes mellitus, *n* (%)	57 (30.0%)	90 (44.5%)	18 (21.2%)	**<0.001**
Dyslipidemia, *n* (%)	159 (83.7%)	182 (90.1%)	61 (71.7%)	**<0.001**
SYNTAX score	18.5 ± 9.4	12.2 ± 8.2	–	**<0.001**

Statistical tests applied include one-way ANOVA for normally distributed continuous variables, Kruskal-Wallis test for non-normally distributed variables, and Chi-square test or Fisher's exact test for categorical data. Post hoc analyses were performed using Mann-Whitney U test where applicable. In the table, statistically significant *p* values ($p < 0.05$) are marked in **bold**. The *p* value indicates the level of statistical significance. Abbreviations: LVEF: Left ventricular ejection fraction; WBC: White blood cell count; GFR: Glomerular filtration rate; PCT: Procalcitonin; CRP: C-reactive protein; BMI: Body mass index; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; ACS: Acute coronary syndrome; CCS: Chronic coronary syndrome.

Table 2. Post hoc comparison of statistically significant variables among CCS (*n* = 202), ACS (*n* = 190), and control (*n* = 85) groups

Variable	CCS vs. control (*p*)	ACS vs. control (*p*)	CCS vs. ACS (*p*)
Age	**<0.001**	**<0.001**	0.045
Male sex	**<0.001**	**<0.001**	0.368
LVEF (%)	0.212	**<0.001**	**<0.001**
WBC (×10³/mL)	**<0.001**	**<0.001**	**<0.001**
Platelet count (×10³/mL)	0.103	0.076	**<0.001**
GFR (mL/min/1.73 m²)	**<0.001**	**0.001**	0.089
HDL cholesterol (mg/dL)	**<0.001**	**<0.001**	0.064
Triglycerides (mg/dL)	0.098	0.116	**<0.001**
PCT (ng/mL)	**<0.001**	**<0.001**	0.029
CRP (mg/L)	0.054	**0.001**	**0.002**
Smoking	0.061	**0.001**	**0.004**
Diabetes mellitus	**<0.001**	0.027	**0.003**
Dyslipidemia	**<0.001**	0.034	0.058

Statistical tests applied include one-way ANOVA for normally distributed continuous variables and Chi-square test for categorical variables. Post hoc comparisons were performed using the Bonferroni-adjusted Mann-Whitney U test or pairwise Chi-square test when appropriate. A Bonferroni-adjusted significance level of $p < 0.017$ was applied for multiple pairwise comparisons. In the table, statistical values that are significant are marked in **bold**. The *p* value indicates the level of statistical significance, with values less than 0.017 considered statistically significant after Bonferroni correction. Abbreviations: LVEF: Left ventricular ejection fraction; WBC: White blood cell count; GFR: Glomerular filtration rate; PCT: Procalcitonin; CRP: C-reactive protein; HDL: High-density lipoprotein; CCS: Chronic coronary syndrome; ACS: Acute coronary syndrome.

Table 3. Multivariate logistic regression analysis for predictors of chronic coronary syndrome (CCS) (*n*=202)

Variable	Odds ratio (OR)	95% confidence interval (CI)	*p* value
Age (years)	1.047	1.01–1.08	**0.008**
Male sex	4.284	2.10–8.76	**<0.001**
Body mass index (BMI)	1.017	0.95–1.09	0.326
Diabetes mellitus (DM)	2.128	0.99–4.60	0.052
Hypertension (HT)	1.277	0.63–2.57	0.492
Smoking	1.547	0.66–3.60	0.313
C-reactive protein (CRP)	0.993	0.90–1.09	0.891
Dyslipidemia	3.471	1.42–8.47	**0.006**
Glomerular filtration rate (GFR)	0.982	0.96–1.00	0.078
Procalcitonin (PCT)*	2.81	1.43–5.54	**<0.001**

Statistical tests applied include multivariate logistic regression analysis to determine independent predictors of chronic coronary syndrome (CCS). *Due to the extremely high odds ratios observed when using raw PCT values in ng/mL, a $\log_{10}$ transformation of procalcitonin was applied to normalize the distribution and provide biologically plausible effect sizes. This transformation yielded a more interpretable odds ratio indicating that each 10-fold increase in PCT level was associated with a nearly 3-fold increase in the likelihood of CCS. In the table, statistical values that are significant are marked in **bold**. The *p* value indicates the level of statistical significance, where values less than 0.05 are considered significant. Abbreviations: OR: Odds ratio; CI: Confidence interval; BMI: Body mass index; DM: Diabetes mellitus; HT: Hypertension; CRP: C-reactive protein; GFR: Glomerular filtration rate; PCT: Procalcitonin.

Table 4. Multivariate logistic regression analysis for predictors of acute coronary syndrome (ACS) (*n*=190)

Variable	Odds ratio (OR)	95% confidence interval (CI)	*p* value
Age (years)	1.108	1.06–1.15	**<0.001**
Male sex	7.498	3.10–18.16	**<0.001**
Body mass index (BMI)	1.085	0.99–1.18	0.078
Diabetes mellitus (DM)	3.207	1.29–7.99	**0.012**
Hypertension (HT)	0.543	0.24–1.22	0.137
Smoking	4.124	1.58–10.73	**0.004**
C-reactive protein (CRP)	1.112	1.02–1.21	**0.011**
Dyslipidemia	3.444	1.34–8.86	**0.010**
Glomerular filtration rate (GFR)	0.990	0.97–1.01	0.273
Procalcitonin (PCT)*	4.30	2.00–9.20	**<0.001**

Statistical tests applied include multivariate logistic regression analysis to determine independent predictors of acute coronary syndrome (ACS). *Due to the extremely high odds ratios observed when using raw PCT values in ng/mL, a $\log_{10}$ transformation of procalcitonin was applied to normalize the distribution and provide biologically plausible effect sizes. This transformation yielded a more interpretable odds ratio indicating that each 10-fold increase in PCT level was associated with a approximately 4-fold increase in the likelihood of ACS. In the table, statistical values that are significant are marked in **bold**. The *p* value indicates the level of statistical significance, where values less than 0.05 are considered significant. Abbreviations: OR: Odds ratio; CI: Confidence interval; BMI: Body mass index; DM: Diabetes mellitus; HT: Hypertension; CRP: C-reactive protein; GFR: Glomerular filtration rate; PCT: Procalcitonin.

Table 5. ROC curve analysis for procalcitonin (PCT) in predicting coronary syndromes (*n*=477)

Comparison group	Sensitivity (%)	Specificity (%)	AUC	*p* value	Cut-off (ng/mL)
CCS vs. control group	89.4	54.0	0.763	**<0.001**	0.30
ACS vs. control group	82.4	65.3	0.791	**<0.001**	0.25

Statistical tests applied include Receiver Operating Characteristic (ROC) curve analysis to evaluate the diagnostic performance of procalcitonin (PCT) in differentiating coronary syndromes. Cut-off values represent the thresholds above which procalcitonin levels were considered elevated for diagnostic classification in ROC analysis. In the table, values that are statistically significant are marked in **bold**. The *p* value indicates the level of statistical significance, where values less than 0.05 are considered significant. Abbreviations: AUC: Area under the curve; ACS: Acute coronary syndrome; CCS: Chronic coronary syndrome; PCT: Procalcitonin.

Table 6. In-hospital and one-year adverse cardiovascular outcomes in ACS patients stratified by PCT Levels

Outcome	PCT ≥0.25 ng/mL (*n*, %)	PCT <0.25 ng/mL (*n*, %)	*p* value
In-hospital mortality	2 (1.6%)	1 (1.6%)	0.994
1-year all-cause mortality	9 (7.0%)	5 (8.2%)	0.743
1-year major adverse cardiovascular events	12 (9.3%)	7 (11.5%)	0.624

Statistical tests applied include Pearson's Chi-Square test and Fisher's Exact Test for categorical variables. In the table, statistical values that are significant are marked in **bold**. The *p* value indicates the level of statistical significance, where values less than 0.05 are considered statistically significant. Abbreviations: ACS: Acute coronary syndromes; PCT: Procalcitonin; MACE: Major adverse cardiovascular events.

SUPPLEMENTAL DATA

Key points

What is known about the topic?

Procalcitonin (PCT) is a well-established biomarker commonly used to detect bacterial infections and assess systemic inflammation. Recent studies have suggested that PCT may also increase in non-infectious inflammatory conditions such as acute coronary syndromes (ACS), potentially reflecting the intensity of systemic inflammation. However, the data on its diagnostic and prognostic utility in both acute and chronic coronary syndromes (CCS) are limited and often conflicting. Moreover, its association with anatomical disease severity, such as quantified by SYNTAX score, has not been fully elucidated.

What does this study add?

This study provides comparative clinical evidence that serum PCT levels are significantly elevated in both ACS and CCS patients compared to controls, supporting its role as a non-infectious inflammatory marker in atherosclerotic disease. Importantly, it identifies PCT as an independent predictor for the presence of both ACS and CCS through multivariate logistic regression analysis. Furthermore, a weak but significant correlation between PCT and SYNTAX score was observed in CCS patients, suggesting that PCT may reflect chronic atherosclerotic burden. Despite these associations, PCT was not predictive of prognosis (mortality or MACE) in ACS patients, highlighting its limited role as a standalone prognostic marker.