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**A Retrospective Cohort Study of Independent Predictors for Long-Term
Prognosis in Patients with Chronic Total Occlusion: Focus on SYNTAX Score
and Platelet-Related Indices**

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Abstract

Objective: The long-term prognosis of patients with chronic total occlusion (CTO) after percutaneous coronary intervention (PCI) is influenced by multiple factors. This study aimed to identify independent predictors of major adverse cardiovascular events (MACE) at one year, with a specific focus on anatomical complexity assessed by the SYNTAX score and platelet activity indices.

Methods: This retrospective cohort study included 310 patients who underwent PCI for at least one CTO between January 2019 and June 2021. Patients were followed for one year for the occurrence of MACE (a composite of cardiac death, target vessel revascularization, non-fatal myocardial infarction, and hospitalization for heart failure). Baseline clinical, angiographic (including SYNTAX score), and laboratory data (including mean platelet volume [MPV], platelet count, and MPV/platelet ratio) were collected. Univariate and multivariate Cox proportional hazards analyses were performed to identify predictors. Kaplan-Meier analysis with log-rank test was used for survival comparisons. Predictive performance was assessed using receiver operating characteristic (ROC) curves.

Results: During follow-up, 64 patients (20.6%) experienced MACE. In univariate analysis, high MPV group (HR 2.13, 95% CI 1.27–3.60, $p=0.004$), lower HDL-cholesterol (HR 0.21, 95% CI 0.06–0.71, $p=0.012$), lower platelet count, higher serum creatinine, and higher MPV/platelet ratio were significant predictors. A risk score incorporating these factors effectively stratified patients (Log-rank $p=0.044$). In multivariable models, lower HDL-cholesterol remained an independent protective factor (HR 0.17, 95% CI 0.05–0.58, $p=0.005$). SYNTAX score was a significant predictor in optimized models (HR 1.04, 95% CI 1.01–1.07, $p=0.020$). Patients with both high SYNTAX score and high MPV had the worst MACE-free survival (Log-rank $p=0.046$). The full predictive model (including age, SYNTAX score, MPV, platelet count, HDL-C, creatinine) showed the best discriminative ability (AUC=0.659). Subgroup analysis indicated the predictive value of SYNTAX score and high MPV was most pronounced in patients aged <65 years.

Conclusion: Lower HDL-cholesterol, higher SYNTAX score, and a profile suggestive of higher platelet activity (high MPV group, lower platelet count) are important predictors of one-year MACE in CTO patients after PCI. A model combining clinical, anatomical, and platelet indices offers improved risk stratification, particularly for identifying high-risk younger patients.

Keywords: Chronic Total Occlusion; Percutaneous Coronary Intervention; SYNTAX Score; Mean Platelet Volume; Prognosis; Major Adverse Cardiovascular Events

1.Introduction

Chronic total occlusion (CTO), defined as a coronary artery obstruction with Thrombolysis in Myocardial Infarction (TIMI) grade 0 flow for over three months, presents a significant challenge in interventional cardiology, often referred to as the "final frontier" of percutaneous coronary intervention (PCI) [1]. While successful CTO-PCI has been associated with improved symptoms, quality of life, and possibly left ventricular function, patient selection and long-term prognostic prediction remain complex [2,3]. Identifying reliable predictors of adverse outcomes is crucial for optimizing therapeutic strategies and resource allocation.

The SYNTAX score, an angiographic tool quantifying coronary artery disease complexity, is a well-established predictor of adverse events after PCI in multivessel disease [4]. Its role in the specific context of CTO-PCI prognosis warrants further investigation. Beyond anatomical complexity, systemic inflammatory and pro-thrombotic states significantly influence cardiovascular outcomes. Platelet indices, such as mean platelet volume (MPV) and platelet count, are readily available biomarkers reflecting platelet activity and turnover. Elevated MPV, indicating larger, more reactive platelets, has been associated with increased cardiovascular risk in various settings, including acute coronary syndromes and stable coronary artery disease [5,6]. However, its prognostic utility specifically in patients undergoing CTO-PCI is less clear.

This study aimed to conduct a comprehensive analysis of independent predictors for one-year major adverse cardiovascular events (MACE) in patients with CTO after PCI. We hypothesized that both anatomical complexity, represented by the SYNTAX score, and a pro-thrombotic profile, indicated by platelet-related indices (MPV, platelet count, MPV/platelet ratio), would be significant and independent determinants of long-term prognosis. By integrating these factors into a predictive model, we seek to enhance risk stratification for this complex patient population.

2.Methods

2.1. Study Design and Population

This was a single-center, retrospective cohort study conducted at Zhongnan Hospital of Wuhan University. The study protocol was approved by the Medical Ethics Committee of Zhongnan Hospital of Wuhan University, Wuhan, China. The study was conducted in accordance with the Declaration of Helsinki and its later amendments. The requirement for informed consent was waived by the Medical Ethics Committee of Zhongnan Hospital of Wuhan University due to the retrospective nature of the study and the use of de-identified data. We screened consecutive patients who underwent coronary angiography between January 2019 and June 2021 and were found to have at least one CTO lesion. CTO was defined as a coronary artery

occlusion with TIMI grade 0 flow or antegrade TIMI flow >0 with bridging collaterals, estimated to be older than 3 months [7].

Inclusion criteria were: 1) Age ≥ 18 years; 2) Successful or failed attempt at CTO-PCI. Exclusion criteria included: 1) Contraindication to dual antiplatelet therapy; 2) Active malignancy or life expectancy <1 year; 3) Presentation with acute myocardial infarction (STEMI or NSTEMI) or cardiogenic shock; 4) Other primary causes of left ventricular dysfunction (e.g., severe valvular heart disease, cardiomyopathy).

2.2. Data Collection and Definitions

Baseline demographic data, clinical history (hypertension, diabetes, dyslipidemia, smoking, prior MI, PCI, or CABG), and medication use at discharge were collected from electronic medical records. Laboratory data obtained within one week prior to the index procedure included complete blood count (platelet count, MPV), lipid profile (total cholesterol, LDL-C, HDL-C, triglycerides), renal function (serum creatinine, estimated glomerular filtration rate [eGFR]), fasting blood glucose, and cardiac biomarkers (creatinine kinase-MB [CK-MB], when available). The MPV/platelet ratio was calculated. Patients were dichotomized into "High MPV" and "Low MPV" groups based on the median MPV value of the cohort.

Coronary angiograms were reviewed by two experienced interventional cardiologists blinded to the clinical outcomes. The SYNTAX score (version 2.11) was calculated for each patient based on the diagnostic angiogram [8]. Successful PCI was defined as the restoration of TIMI grade 3 flow in the CTO vessel with residual stenosis <30%, with or without stent implantation. PCI failure included failed wiring, inability to cross the lesion with a balloon, or failure to achieve final TIMI 3 flow.

2.3. Follow-up and Study Endpoint

Patients were followed for one year post-procedure via clinic visits, hospital readmission records, or telephone interviews. The primary endpoint was the occurrence of Major Adverse Cardiovascular Events (MACE), a composite of cardiac death, non-fatal myocardial infarction, target vessel revascularization (TVR), and hospitalization for heart failure.

2.4. Statistical Analysis

Continuous variables were presented as mean $\pm$ standard deviation (SD) or median (interquartile range [IQR]) as appropriate, and compared using Student's t-test or Mann-Whitney U test. Categorical variables were expressed as frequencies (percentages) and compared using the Chi-square or Fisher's exact test. Univariate Cox proportional hazards regression was used to assess the association between candidate variables and MACE. Variables with a p-value <0.10 in univariate analysis or deemed clinically relevant were entered into multivariate Cox regression models using a backward stepwise elimination process (retention criterion $p < 0.05$) to identify independent predictors.

Kaplan-Meier survival curves were constructed to compare MACE-free survival between groups, with differences assessed by the log-rank test. A risk score was developed based on the beta-coefficients of independent predictors from the final Cox model. The discriminative ability of the SYNTAX score, MPV, their combination, and the full clinical model for predicting 12-month MACE was evaluated using the area under the receiver operating characteristic curve (AUC). Subgroup analyses were performed to assess the consistency of key predictors across different populations (e.g., age, diabetes status, renal function). A two-sided p-value <0.05 was considered statistically significant. All analyses were performed using SPSS version 25.0 (IBM Corp.) and R software (version 4.0.3).

3. Results

3.1. Baseline Characteristics

A total of 310 patients were included in the final analysis. The overall mean age was 62.9 ± 10.6 years, and 74.8% were male. During the one-year follow-up, 64 patients (20.6%) experienced at least one MACE. Baseline characteristics stratified by MACE occurrence are presented in **Table 1**. Compared to the No-MACE group (n=246), patients who developed MACE were older and had significantly lower platelet counts (189.9 ± 46.9 vs. 212.8 ± 58.4 , $p=0.004$), lower HDL-cholesterol levels (0.93 ± 0.17 vs. 1.02 ± 0.25 mmol/L, $p=0.009$), and higher serum creatinine (121.0 ± 168.4 vs. 88.4 ± 46.5 $\mu\text{mol/L}$, $p=0.008$). A significantly higher proportion of MACE patients were classified in the high MPV group (67.2% vs. 45.5%, $p=0.003$). There were no significant differences in conventional risk factors, SYNTAX score, or procedural success rate between the groups.

3.2. Predictors of MACE

The results of the univariate Cox regression analysis are shown in **Table 2**. High MPV group (HR 2.13, 95% CI 1.27–3.60, $p=0.004$), MPV/platelet ratio (HR 52005.37, 95% CI 3.57–7.58e8, $p=0.026$), lower HDL-cholesterol (HR 0.21, 95% CI 0.06–0.71, $p=0.012$), lower platelet count (HR 0.994, 95% CI 0.989–0.998, $p=0.007$), and higher serum creatinine (HR 1.002, 95% CI 1.001–1.004, $p=0.001$) were significantly associated with MACE.

In the primary multivariable Cox model adjusting for age, SYNTAX score, high MPV group, platelet count, and serum creatinine, lower HDL-cholesterol emerged as the strongest independent protective factor (HR 0.17, 95% CI 0.05–0.58, $p=0.005$) (**Table 3**). The association of high MPV group with MACE was attenuated (HR 1.85, 95% CI 0.89–3.87, $p=0.099$). A forest plot of an optimized multivariate model is presented in **Figure 1**, highlighting key hazard ratios. Further model optimization identified SYNTAX score (HR 1.04, 95% CI 1.01–1.07, $p=0.020$) and serum creatinine as significant independent predictors in certain model constructs.

3.3. Risk Stratification and Combined Prognostic Value

A risk score was developed from key univariate predictors, categorizing patients into low-, intermediate-, and high-risk tertiles. Kaplan-Meier analysis demonstrated significantly different MACE-free survival among these groups (Log-rank $p = 0.044$), with the high-risk group having the worst prognosis (**Figure 2**).

Although the mean MPV value was not significantly different between MACE and non-MACE groups (9.93 vs. 9.62 fL, $p=0.11$; **Figure 3**), its categorical combination with SYNTAX score provided strong prognostic stratification. Patients with both a high SYNTAX score and high MPV status had the lowest probability of MACE-free survival (Log-rank $p = 0.046$; **Figure 4**). The relationship between SYNTAX score and MPV is depicted in **Figure 5**, showing a scattered distribution without strong collinearity.

3.4. Predictive Model Performance

The discriminatory power of various models for predicting 12-month MACE was evaluated using ROC analysis (**Figure 6**). The SYNTAX score alone had limited predictive value (AUC = 0.561), as did MPV alone (AUC = 0.565). Their combination improved the AUC to 0.588. The comprehensive clinical model, incorporating age, SYNTAX score, high MPV group, platelet count, HDL-cholesterol, and serum creatinine, achieved the highest AUC of 0.659. A comparison of AUCs is summarized in **Figure 7A**. The performance metrics (sensitivity, specificity, accuracy, predictive values) for the different models are detailed in **Figure 7B**.

3.5. Subgroup Analysis

Subgroup analyses were conducted to assess the consistency of the effects of SYNTAX score and high MPV status (**Table 4**). The association between higher SYNTAX score and increased MACE risk was particularly strong in patients aged <65 years (HR 1.06, 95% CI 1.02–1.11, $p=0.007$). Similarly, the predictive value of high MPV status was most evident in the younger subgroup (<65 years) (HR 1.43, 95% CI 1.04–1.96, $p=0.027$).

4. Discussion

This retrospective cohort study identified several independent and significant predictors of one-year MACE in patients undergoing PCI for CTO. The key findings are: (1) A lower HDL-cholesterol level was the strongest independent protective factor; (2) Higher SYNTAX score and serum creatinine were independent risk factors in optimized models; (3) Platelet-related parameters, particularly classification into a high MPV group and lower platelet count, were significant univariate predictors and contributed to effective risk stratification; (4) The combination of high anatomical complexity (SYNTAX score) and high platelet activity (MPV) identified a subgroup with the poorest prognosis; (5) A comprehensive model integrating clinical, anatomical, and laboratory data offered the best predictive performance.

The inverse association between HDL-C and cardiovascular risk is well-established [9]. HDL-C participates in reverse cholesterol transport and possesses anti-inflammatory, antioxidant, and endothelial-protective properties [10]. Our finding reinforces its critical prognostic value even in the complex setting of CTO-PCI, suggesting that aggressive management of dyslipidemia remains paramount.

While the SYNTAX score is a validated tool for risk assessment in multivessel PCI [4, 11], its independent prognostic value in CTO-specific cohorts has been debated. Our results, showing its significance in optimized models and a pronounced effect in younger patients, suggest that anatomical complexity remains a crucial determinant of long-term outcome, potentially more so in patients with longer life expectancy. This aligns with recent studies emphasizing the role of SYNTAX score in guiding CTO-PCI strategy and predicting complications [12].

The prognostic importance of platelet indices is a notable finding. MPV is a marker of platelet size and activity; larger platelets are metabolically and enzymatically more active, with greater thrombotic potential [5, 13]. Previous studies have linked high MPV to worse outcomes in acute coronary syndromes [6] and after PCI [14]. Our study extends this evidence to the CTO population. The significant predictive value of the MPV/platelet ratio, a composite marker, and lower platelet count further underscores the role of a pro-thrombotic platelet phenotype. Interestingly, while the mean MPV did not differ, the categorical "high MPV" classification was predictive, highlighting a potential threshold effect. The synergistic poor prognosis observed in patients with both high SYNTAX score and high MPV suggests an interplay between a complex anatomical substrate and a hyper-reactive systemic milieu, a hypothesis that merits further investigation.

The superior performance of the full integrated model (AUC=0.659) over individual factors underscores the multifactorial nature of post-CTO PCI prognosis. This model, with its high specificity (0.85) and negative predictive value (0.93), could be clinically useful for identifying low-risk patients in whom conservative management or less aggressive intervention might be appropriate. The high NPV is particularly valuable for reassuring patients and clinicians.

The subgroup finding that SYNTAX score and MPV are most predictive in patients <65 years is intriguing. Younger patients may have less comorbid burden, making the specific impact of coronary anatomy and platelet biology more discernible. Alternatively, this may reflect a different pathophysiology or a longer timeframe for risk accrual.

Limitations: This study has limitations inherent to its single-center, retrospective design. Unmeasured confounding factors may persist despite multivariate adjustment. The sample size, while substantial, limited more granular subgroup analyses. The

follow-up duration was one year; longer-term outcomes may differ. External validation of the proposed predictive model is required in independent, prospective cohorts.

5. Conclusion

In patients undergoing PCI for CTO, lower HDL-cholesterol, higher SYNTAX score, and a platelet profile indicative of higher activity (high MPV group, lower platelet count) are significant predictors of one-year MACE. A simple combined assessment of SYNTAX score and MPV status effectively identifies a very high-risk subgroup. An integrated risk model incorporating these factors demonstrates improved predictive ability for long-term prognosis, offering a tool for enhanced risk stratification and personalized management in this challenging patient population.

Declarations

Abbreviations

AUC: area under the curve; BMI: body mass index; CABG: coronary artery bypass grafting; CI: confidence interval; CK-MB: creatine kinase-MB; CTO: chronic total occlusion; eGFR: estimated glomerular filtration rate; HDL-C: high-density lipoprotein cholesterol; HR: hazard ratio; IQR: interquartile range; LDL-C: low-density lipoprotein cholesterol; MACE: major adverse cardiovascular events; MPV: mean platelet volume; PCI: percutaneous coronary intervention; ROC: receiver operating characteristic; SD: standard deviation; SYNTAX: Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery; TIMI: Thrombolysis in Myocardial Infarction; TVR: target vessel revascularization.

Ethics approval and consent to participate

The study was approved by the Medical Ethics Committee of Zhongnan Hospital of Wuhan University, Wuhan, China, and was conducted in accordance with the Declaration of Helsinki and its later amendments. All procedures involving human participants were performed in accordance with the ethical standards of the institutional and/or national research committee. The requirement for informed consent was waived by the Medical Ethics Committee of Zhongnan Hospital of Wuhan University due to the retrospective nature of the study and the use of de-identified data.

Consent for publication

This manuscript does not contain any identifying images or other personal or clinical details of individual participants that could compromise anonymity. All clinical and laboratory data are presented in aggregate or de-identified form. Therefore, no separate consent for publication was required.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to patient privacy and ethical restrictions, but are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Authors' contributions

WZ conceived and designed the study, developed the methodology, performed the formal statistical analysis, supervised the project, and wrote and revised the manuscript. SH was responsible for data collection, curation, and investigation, conducted parts of the formal analysis, and contributed to writing the original draft. TG provided critical resources for the investigation, assisted in data validation, and participated in reviewing and editing the manuscript. All authors read and approved the final manuscript.

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Table 1. Baseline Characteristics of the Study Cohort Stratified by the Occurrence of Major Adverse Cardiovascular Events (MACE)

	level	Overall	No MACE	MACE	P
n		310	246	64	
Age (mean (SD))		62.89 (10.60)	62.34 (10.63)	65.03 (10.28)	0.07
Age group (%)	<65	176 (56.8)	144 (58.5)	32 (50.0)	0.339
	65-75	103 (33.2)	80 (32.5)	23 (35.9)	
	>75	31 (10.0)	22 (8.9)	9 (14.1)	
Gender (%)	Female	78 (25.2)	62 (25.2)	16 (25.0)	1
	Male	232 (74.8)	184 (74.8)	48 (75.0)	
Syntax score (median [IQR])		28.50 [22.00, 35.00]	27.75 [22.50, 34.50]	31.00 [22.00, 38.62]	0.14
Syntax group (%)	Low (0-22)	79 (25.5)	61 (24.8)	18 (28.1)	0.137
	Intermediate (23-32)	120 (38.7)	102 (41.5)	18 (28.1)	
	High (>32)	111 (35.8)	83 (33.7)	28 (43.8)	
Hypertension (%)	No	108 (34.8)	87 (35.4)	21 (32.8)	0.814
	Yes	202 (65.2)	159 (64.6)	43 (67.2)	
Diabetes (%)	No	198 (63.9)	158 (64.2)	40 (62.5)	0.912
	Yes	112 (36.1)	88 (35.8)	24 (37.5)	
Hyperlipidemia (%)	No	265 (85.5)	208 (84.6)	57 (89.1)	0.476
	Yes	45 (14.5)	38 (15.4)	7 (10.9)	
Myocardial infarction (%)	No	290 (93.5)	232 (94.3)	58 (90.6)	0.434
	Yes	20 (6.5)	14 (5.7)	6 (9.4)	
Smoking (%)	No	174 (56.1)	138 (56.1)	36 (56.2)	1
	Yes	136 (43.9)	108 (43.9)	28 (43.8)	
Drinking (%)	No	237 (76.5)	188 (76.4)	49 (76.6)	1
	Yes	73 (23.5)	58 (23.6)	15 (23.4)	
BMI (mean (SD))		24.97 (3.59)	25.03 (3.48)	24.75 (3.99)	0.59
BMI group (%)	Underweight	4 (1.3)	3 (1.2)	1 (1.6)	0.967
	Normal	165 (53.2)	130 (52.8)	35 (54.7)	
	Overweight	119 (38.4)	96 (39.0)	23 (35.9)	
	Obese	22 (7.1)	17 (6.9)	5 (7.8)	
Systolic blood pressure (mean (SD))		130.43 (17.91)	131.32 (18.29)	127.03 (16.04)	0.088
Diastolic blood pressure (mean (SD))		76.35 (10.87)	76.76 (11.18)	74.80 (9.55)	0.2
Left ventricular ejection fraction (mean (SD))		57.08 (12.21)	57.62 (12.19)	55.05 (12.15)	0.134
Lvef group (%)	Reduced (<40%)	34 (11.0)	26 (10.6)	8 (12.5)	0.195
	Mid-range (40-50%)	43 (13.9)	30 (12.2)	13 (20.3)	
	Preserved (>50%)	233 (75.2)	190 (77.2)	43 (67.2)	
Hemoglobin (mean (SD))		133.58 (16.71)	133.88 (16.78)	132.43 (16.53)	0.538
Platelet count (mean (SD))		208.06 (56.93)	212.79 (58.44)	189.89 (46.85)	0.004
Mean platelet volume (mean (SD))		9.69 (1.40)	9.62 (1.42)	9.93 (1.33)	0.118
Mpv PLT ratio (median [IQR])		0.05 [0.04, 0.06]	0.05 [0.04, 0.06]	0.05 [0.04, 0.06]	0.002
High mpv group (%)	Low	155 (50.0)	134 (54.5)	21 (32.8)	0.003
	High	155 (50.0)	112 (45.5)	43 (67.2)	
Total cholesterol (mean (SD))		4.03 (1.17)	4.04 (1.20)	3.99 (1.04)	0.734
Ldl cholesterol (mean (SD))		2.41 (0.91)	2.41 (0.93)	2.44 (0.84)	0.769
Hdl cholesterol (mean (SD))		1.00 (0.24)	1.02 (0.25)	0.93 (0.17)	0.009
Triglycerides (median [IQR])		1.52 [1.03, 2.12]	1.56 [1.02, 2.18]	1.37 [1.05, 1.83]	0.176
Serum creatinine (mean (SD))		95.10 (87.55)	88.37 (46.45)	120.99 (168.36)	0.008
Estimated GFR (mean (SD))		84.53 (27.28)	85.88 (26.23)	79.32 (30.66)	0.087
Fasting blood glucose (mean (SD))		6.74 (2.99)	6.81 (3.19)	6.44 (1.99)	0.376
Uric acid (mean (SD))		397.24 (117.39)	392.14 (112.49)	416.83 (133.77)	0.134

Data are presented as mean $\pm$ standard deviation, median [interquartile range], or n

(%). P-values were derived from independent samples t-test, Mann-Whitney U test, or Chi-square test as appropriate. MPV: Mean Platelet Volume.

Table 2. Univariate Cox Proportional Hazards Regression Analysis for Predictors of One-Year MACE

Predictor	HR	CI lower	CI upper	P value	HR 95CI
Age	1.023	0.999	1.048	0.063	1.02 (1.00-1.05)
Gender	1.003	0.569	1.765	0.993	1.00 (0.57-1.76)
Syntax_score	1.023	0.998	1.05	0.0703	1.02 (1.00-1.05)
Hypertension	1.101	0.653	1.854	0.7191	1.10 (0.65-1.85)
Diabetes	1.087	0.655	1.803	0.7468	1.09 (0.66-1.80)
Myocardial_infarction	1.602	0.691	3.712	0.272	1.60 (0.69-3.71)
Smoking	0.986	0.602	1.616	0.9554	0.99 (0.60-1.62)
BMI	0.979	0.911	1.053	0.5665	0.98 (0.91-1.05)
Left ventricular ejection fraction	0.986	0.968	1.004	0.1285	0.99 (0.97-1.00)
Mean platelet volume	1.14	0.964	1.349	0.1256	1.14 (0.96-1.35)
High mpv group	2.134	1.266	3.597	0.0044* *	2.13 (1.27-3.60)
Mpv plt ratio	52005.372	3.566	758489587.1	0.0264*	52005.37 (3.57-758489587.06)
Platelet count	0.994	0.989	0.998	0.007**	0.99 (0.99-1.00)
Ldl cholesterol	1.069	0.825	1.385	0.6154	1.07 (0.82-1.38)
Hdl cholesterol	0.206	0.06	0.709	0.0122*	0.21 (0.06-0.71)
Serum creatinine	1.002	1.001	1.004	0.0014* *	1.00 (1.00-1.00)

CI: Confidence Interval; HR: Hazard Ratio. MPV: Mean Platelet Volume. *p < 0.05, **p < 0.01.

Table 3. Multivariable Cox Proportional Hazards Regression Analysis for Independent Predictors of One-Year MACE

Predictor	HR	CI lower	CI upper	P value	HR 95CI
Age	1.021	0.994	1.049	0.1284	1.02 (0.99-1.05)
Syntax score	1.023	0.996	1.05	0.0924	1.02 (1.00-1.05)
High mpv group	1.855	0.89	3.868	0.0992	1.85 (0.89-3.87)
Mpv PlT ratio	0	0	190422.246	0.3591	0.00 (0.00-190422.25)
Platelet count	0.995	0.986	1.005	0.336	0.99 (0.99-1.00)
Hdl cholesterol	0.166	0.048	0.581	0.005**	0.17 (0.05-0.58)
Serum creatinine	1.001	1	1.003	0.0702	1.00 (1.00-1.00)

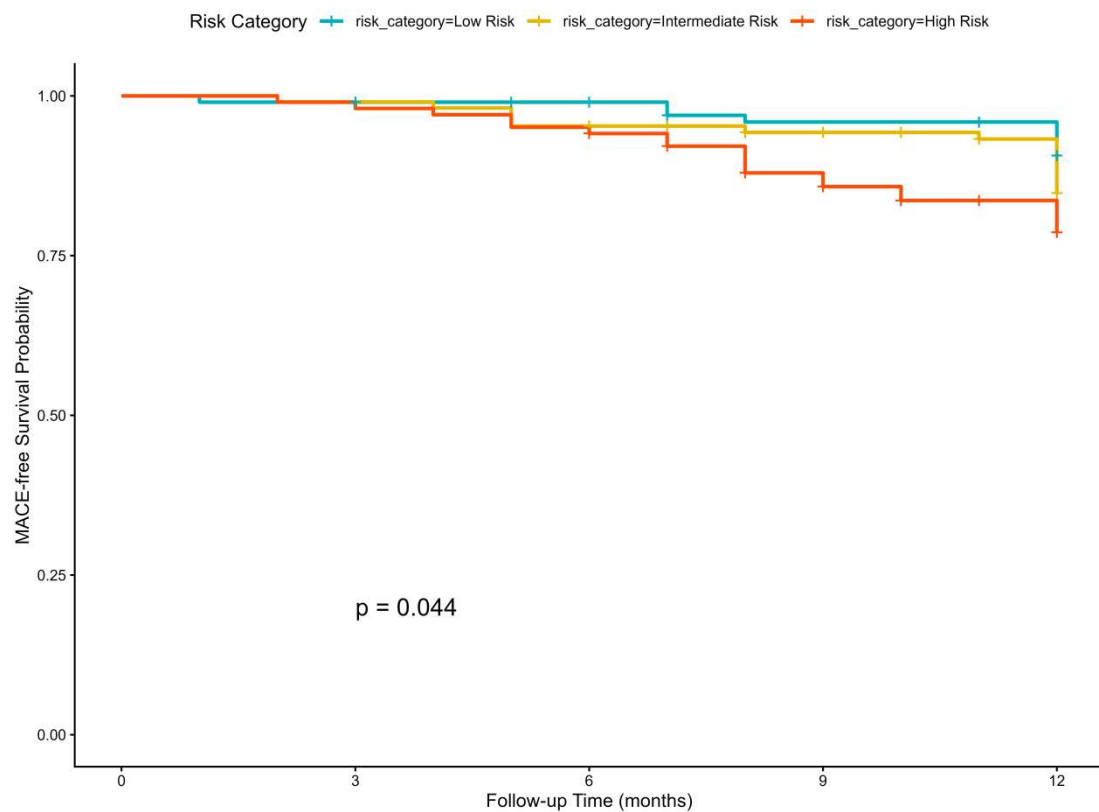
The model was adjusted for age, SYNTAX score, high MPV group, platelet count, HDL-cholesterol, and serum creatinine. CI: Confidence Interval; HR: Hazard Ratio. MPV: Mean Platelet Volume. *p < 0.05, **p < 0.01.

Table 4. Subgroup Analysis of the Association Between SYNTAX Score, High MPV Status, and MACE Risk

Subgroup	N	Events	SYNTAX HR	SYNTAX P	MPV HR	MPV P
Age 65-75	103	20	1.02	0.3598	0.98	0.9051
Age <65	176	18	1.06	0.0071	1.43	0.0269
Age >75	31	6	1	0.9618	0.72	0.3889
Diabetes 1	112	21	1.04	0.0739	1.07	0.6652
Diabetes 0	198	23	1.04	0.1144	1.1	0.51
GFR Moderate reduction	53	9	1.08	0.0181	0.99	0.9614
GFR Normal	134	15	1.03	0.1756	1.12	0.559
GFR Mild reduction	116	17	1.03	0.2858	1.08	0.67

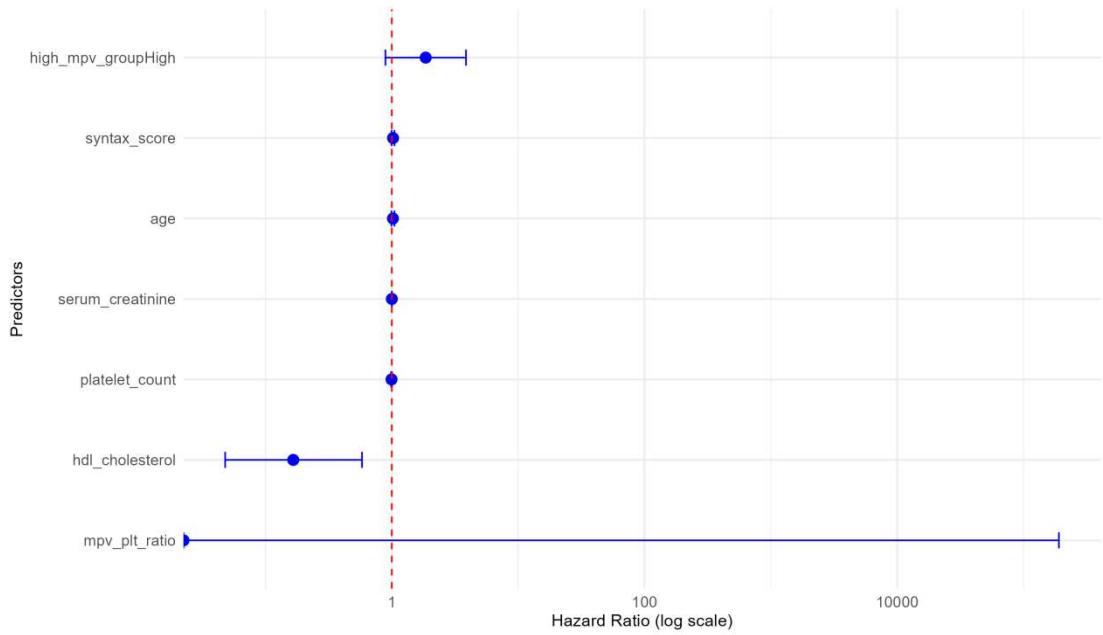
HR for SYNTAX score represents per-unit increase. HR for MPV represents High vs. Low MPV group. MPV: Mean Platelet Volume. GFR: Glomerular Filtration Rate.

Figure 1. Forest Plot of Hazard Ratios for Key Predictors in an Optimized Multivariate Cox Regression Model



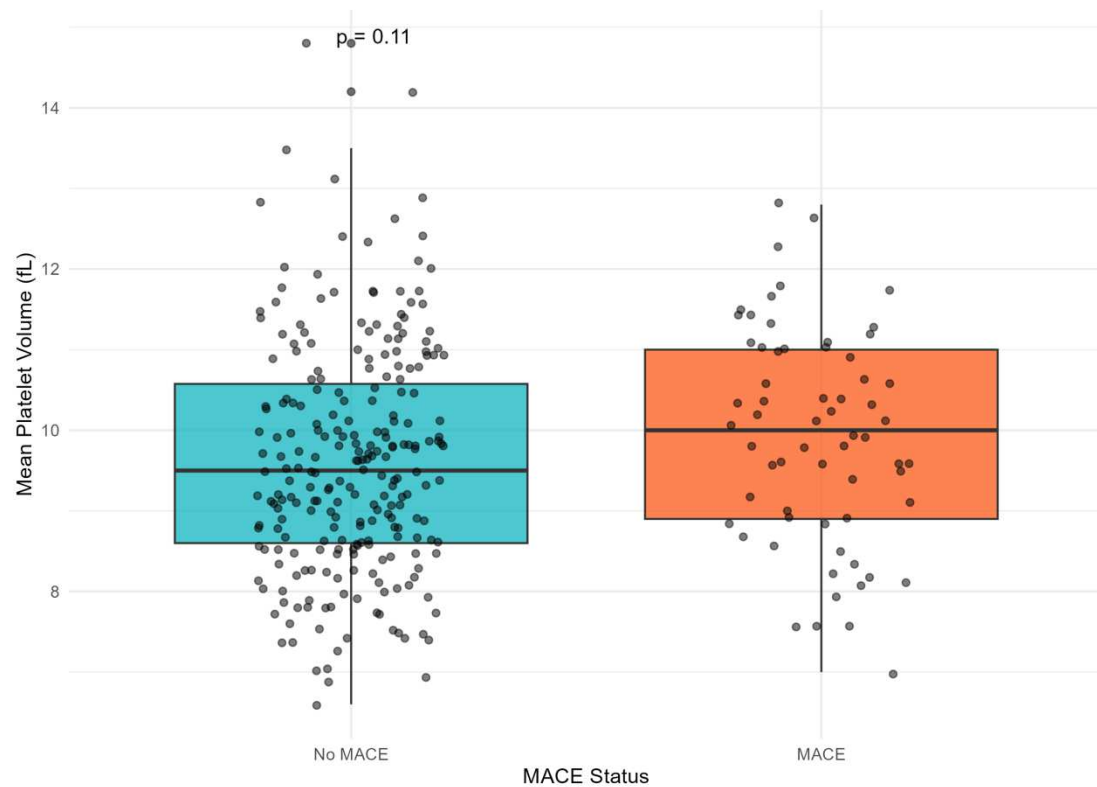
The forest plot displays the adjusted hazard ratios (squares) and 95% confidence intervals (horizontal lines) for variables retained in an optimized predictive model for MACE. MPV: Mean Platelet Volume.

Figure 2. Kaplan-Meier Curves for MACE-free Survival Stratified by Risk Score Tertiles



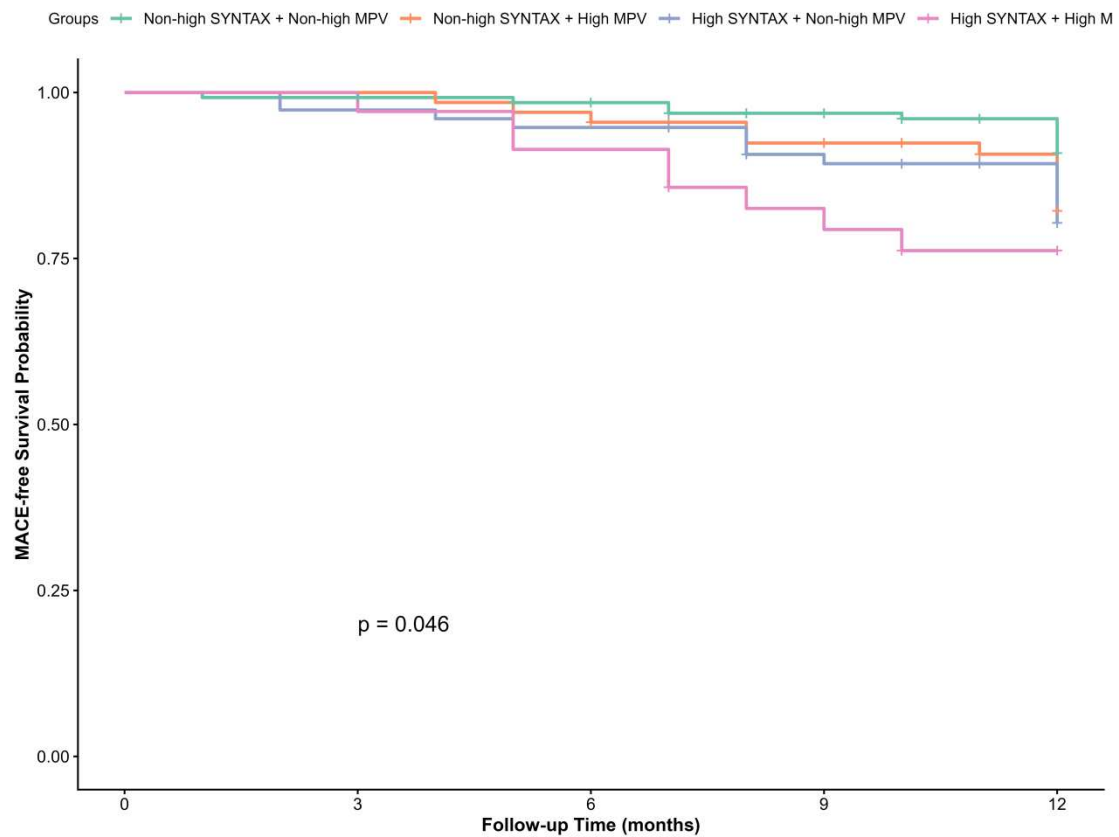
Patients were categorized into low-, intermediate-, and high-risk groups based on a risk score derived from key predictors. The difference in survival was assessed using the log-rank test. MACE: Major Adverse Cardiovascular Events.

Figure 3. Comparison of Mean Platelet Volume (MPV) Between Patients With and Without MACE



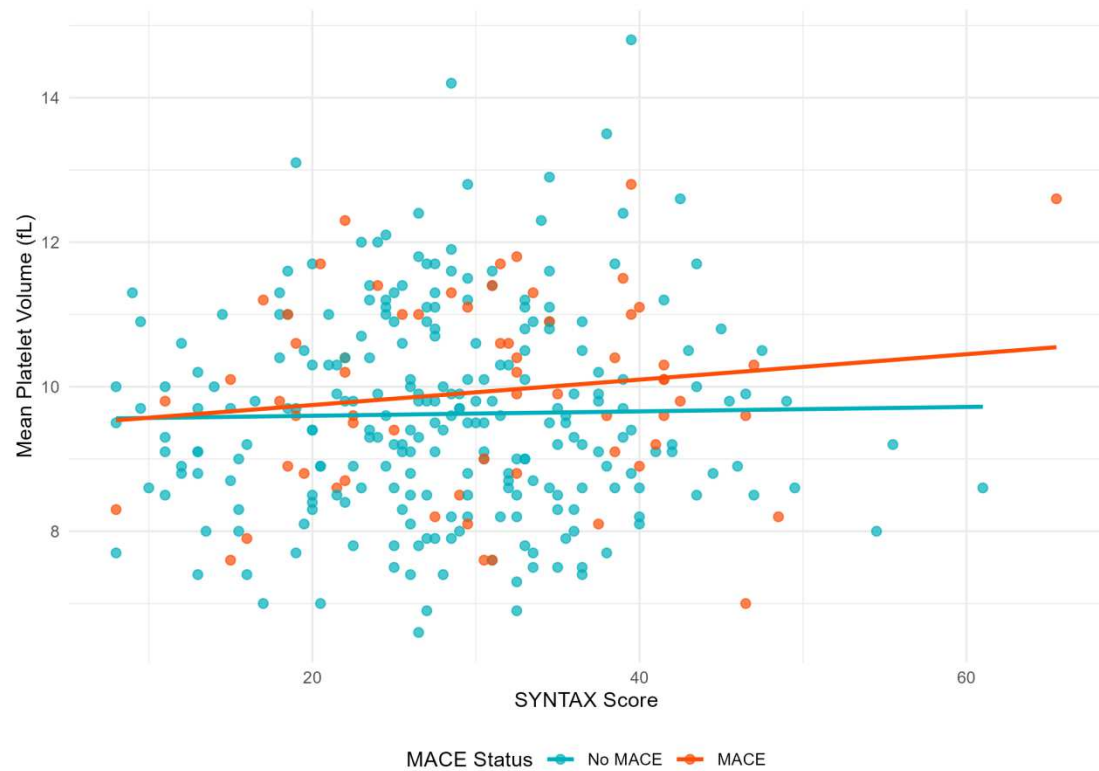
The box plot shows the distribution of Mean Platelet Volume (fL) in the two groups. The central line represents the median, the box the interquartile range, and the whiskers the range. P-value is from the Mann-Whitney U test. MACE: Major Adverse Cardiovascular Events.

Figure 4. Kaplan-Meier Survival Curves by Combined SYNTAX Score and MPV Groups



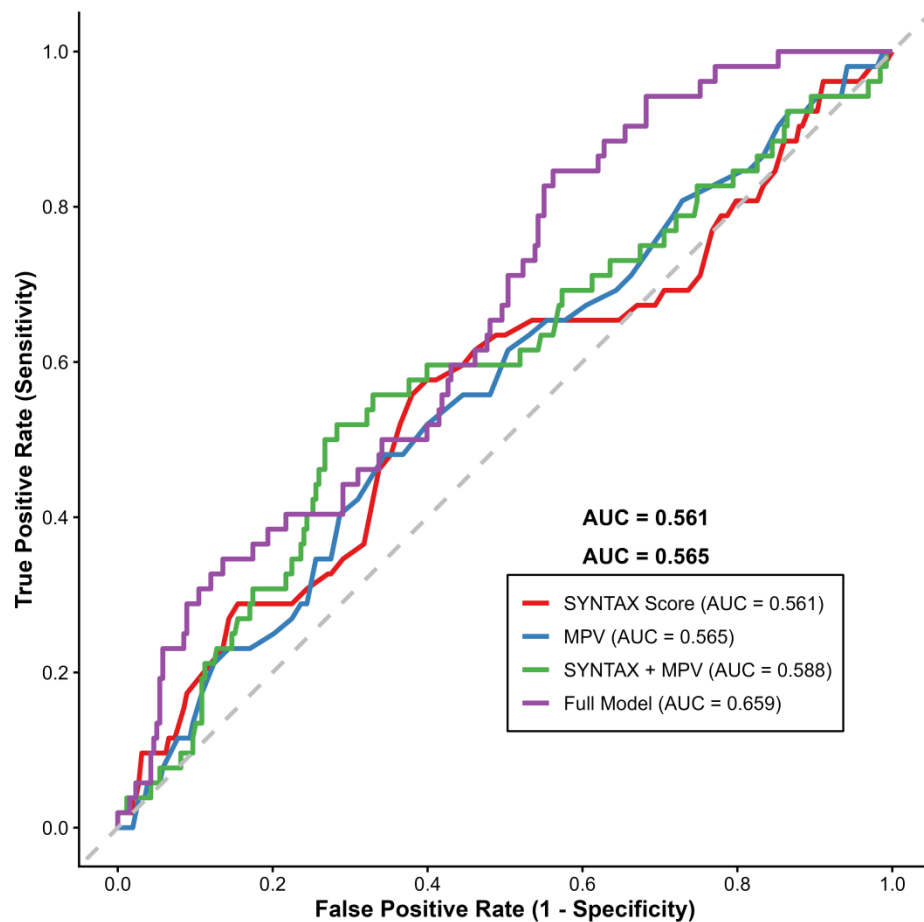
Patients were stratified into four groups based on SYNTAX score (High: >32 ; Non-high: ≤ 32) and MPV status (High vs. Low, based on median value). The group with both High SYNTAX and High MPV showed the worst prognosis (log-rank $p=0.046$). MPV: Mean Platelet Volume. MACE: Major Adverse Cardiovascular Events.

Figure 5. Scatter Plot of SYNTAX Score Versus Mean Platelet Volume (MPV)
Colored by MACE Status



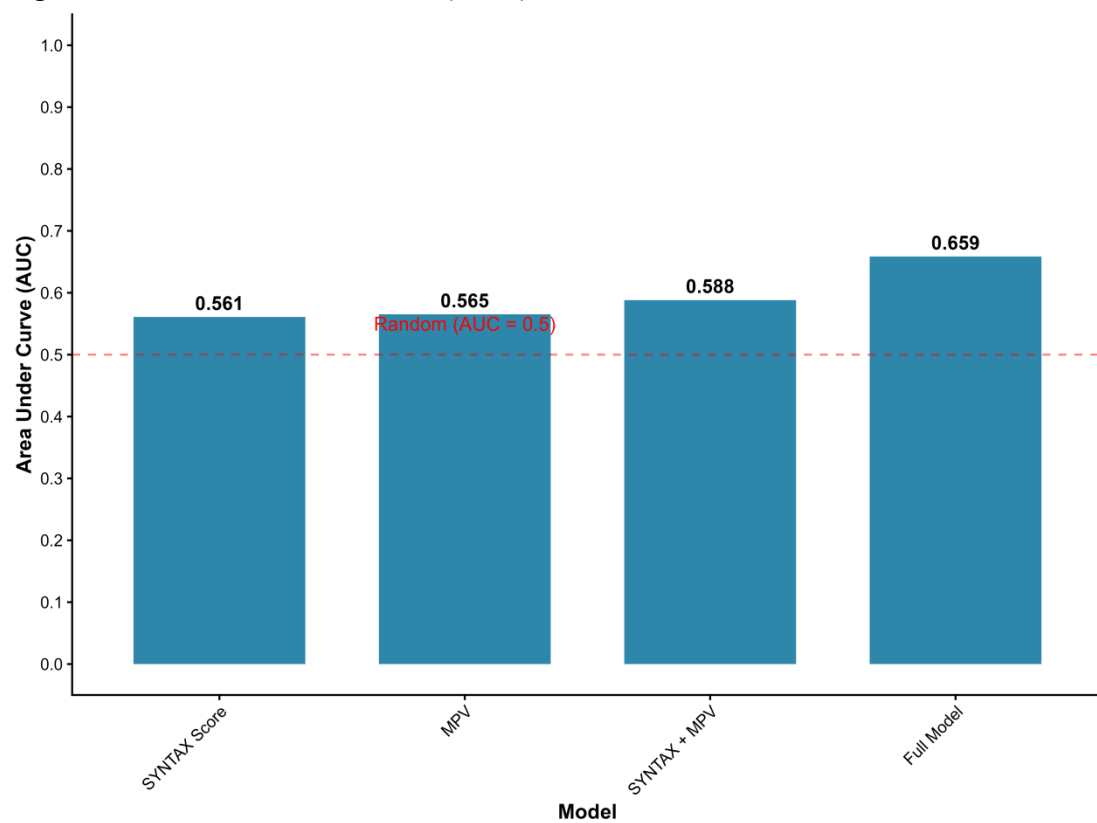
Each point represents one patient. No strong linear correlation is observed between the two variables. The dispersion of red points (MACE) indicates the multifactorial nature of risk. MPV: Mean Platelet Volume. MACE: Major Adverse Cardiovascular Events.

Figure 6. Receiver Operating Characteristic (ROC) Curves for Different Models Predicting 12-Month MACE



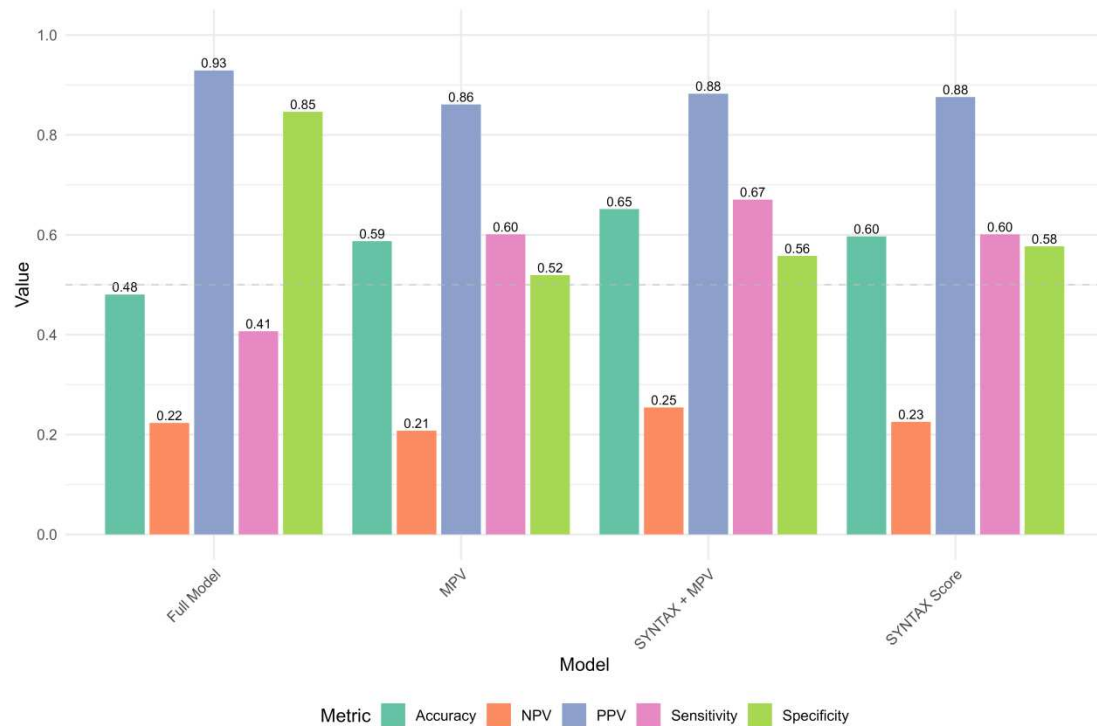
The curves compare the discriminatory ability of the SYNTAX score alone, MPV alone, their combination, and the full clinical model. The diagonal line represents chance (AUC=0.5). AUC: Area Under the Curve. MPV: Mean Platelet Volume. MACE: Major Adverse Cardiovascular Events.

Figure 7A. Area Under the Curve (AUC) Values for Different Prediction Models



Bar graph comparing the AUC of the SYNTAX score, MPV, their combination (SYNTAX+MPV), and the full integrated model. The dashed line indicates the reference AUC of 0.5. MPV: Mean Platelet Volume.

Figure 7B. Performance Metrics (Accuracy, Sensitivity, Specificity, PPV, NPV) of Different Prediction Models



The bar graph displays key performance metrics for the SYNTAX score, MPV, their combination (SYNTAX+MPV), and the full integrated model. PPV: Positive Predictive Value; NPV: Negative Predictive Value. MPV: Mean Platelet Volume.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Tables.docx](#)