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SYNTAX Score II as a Predictor of One-Year Major Adverse Cardiovascular Events in Patients with Chronic Coronary Syndrome and Type 2 Diabetes Mellitus Undergoing Percutaneous Coronary Intervention

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ABSTRACT

Background: The severity of coronary atherosclerotic lesions is an important determinant of cardiovascular events in patients with CAD. The SS-II (SYNTAX-II) score, which integrates anatomical characteristics with clinical variables, provides improved prognostic value compared with anatomical scoring alone. **Objective:** To determine whether the SS-II predicts one-year MACE in CCS patients with T2DM who undergo PCI. **Methods:** This observational analytic study employed a retrospective cohort design including patients treated from June 2023 to August 2024. A total of 128 CCS patients with T2DM who underwent PCI were enrolled. Bivariate and multivariate analyses were performed to examine the association between the SS-II and MACE. One-year MACE-free survival was analyzed using Kaplan–Meier curves. **Results:** MACE occurred more frequently among patients with high SS-II scores (22 [34.4%], $P < 0.001$). Mortality and acute heart failure were both significantly associated with the SS-II ($P = 0.042$ and $P = 0.03$, respectively). Patients with high scores had significantly lower one-year MACE-free survival. **Conclusion:** The SS-II is a valuable predictor of one-year MACE in CCS patients with T2DM undergoing PCI.

Keywords: chronic coronary syndrome, major adverse cardiovascular events, syntax II, type 2 diabetes mellitus

1. Introduction

Coronary Artery Disease (CAD) is one of the leading causes of mortality worldwide, with its prevalence and death rates continuing to rise, particularly in low and middle-income countries. The clinical course of CAD is dynamic, presenting as either Acute Coronary Syndrome (ACS) or Chronic Coronary Syndrome (CCS) [1].

The SYNTAX score (SS) is an angiographic grading system designed to evaluate the extent and complexity of CAD. By combining coronary anatomical features with lesion morphology, it serves as an indicator of overall atherosclerotic burden and the technical difficulty of revascularization procedures such as PCI [2,3]. The SS was introduced in the SYNTAX study as a tool for stratifying risk among patients undergoing either coronary artery bypass grafting (CABG) or PCI. First introduced in the SYNTAX trial, the

score demonstrated prognostic utility, as patients with moderate-high values (>22) achieved superior outcomes with CABG compared to those undergoing PCI [2,4,5,6].

The SYNTAX score II (SS-II), which incorporates demographic, clinical, and angiographic variables, has shown greater predictive value for mortality than the original SS. Unlike its predecessor, SS-II generates separate risk estimates for PCI and CABG, offering prognostic information on 4-year mortality [3,4,7,8]. Type 2 diabetes mellitus is an important risk factor for CAD and is strongly associated with more diffuse and complex atherosclerosis and an increased incidence of MACE. Despite its clinical relevance, DM-2 was not included as a variable in the SS-II. In the original SYNTAX study, multivariate analyses demonstrated that the prognostic effect of DM-2 was largely mediated through other clinical parameters already integrated into the model. As a result, DM-2 did not emerge as an independent predictor of 4-year mortality and was excluded from the final SS-II algorithm to prevent redundancy and maintain model accuracy [4,3,9,10].

However, evidence evaluating the association between SS-II and clinical outcomes in patients with CCS and DM-II undergoing PCI in Asian populations remains limited, and to our knowledge, no prior study has reported such findings in Indonesian patients. Therefore, this study aims to address this gap by assessing the relationship between SS-II and MACE in this specific cohort.

2. Methods

Study design, setting, and patient population

This single-centre retrospective cohort study at Adam Malik Hospital included CCS patients with type 2 diabetes who underwent PCI between June 2023 and August 2024. Eligible patients had complete records and provided informed consent; those with incomplete data or significant valvular disease were excluded. Baseline clinical, laboratory, echocardiographic, and angiographic data were collected, and SS-II was calculated from initial coronary angiography.

Data collection

SS-II was derived from all lesions ≥50% in vessels ≥1.5 mm using the online SYNTAX calculator. Scores were categorized as low–intermediate (≤27.7) or high (>27.7). Two blinded interventional cardiologists independently assessed the SS-II.

Study endpoints

The primary endpoint was 12-month MACE, including cardiovascular mortality, acute heart failure, cardiogenic shock, malignant arrhythmia, and stroke.

Data analysis

Categorical variables were compared using the chi-square or Fisher's exact test; continuous variables using the T-test or Mann–Whitney U test. Multivariate logistic regression identified independent predictors of MACE. Kaplan–Meier curves were generated by the SS-II group. Analyses used SPSS® version 27.0, with significance at $p < 0.05$.

3. Results

Characteristics of the Patient

Between June 2023 and August 2024, a total of 128 patients with CCS and DM-2 who underwent PCI were included in this study. Baseline clinical and angiographic characteristics according to patient categories are presented in Table 1. Among patients with coronary artery disease, the majority were male (n = 92, 71.9%), while females accounted for 36 patients (28.1%). The mean age of the study population was 60.64 years. The prevalence of hypertension, dyslipidemia, and smoking was 46.1% (n = 59), 43.8% (n = 56), and 51.6% (n = 66), respectively. Chronic obstructive pulmonary disease (COPD) was identified in 46 patients (35.9%), whereas no cases of peripheral vascular disease (PVD) were observed. The mean SS was 18 ± 6.15, and the mean SS-II was 28.07 ± 9.54. MACE occurred in 24 patients (18.8%) within the study population.

Table 1. Baseline Characteristics

Variables	n = 128
Sex (%)	
Male	92 (71.9)
Female	36 (28.1)
Hypertension (%)	
Yes	59 (46.1)
No	69 (53.9)
Dyslipidemia(%)	
Yes	56 (43.8)
No	72 (56.3)
Smoker (%)	
Yes	66 (51.6)
No	62 (48.4)
COPD (%)	
Yes	46 (35.9)
No	82 (64.1)
PVD (%)	
Yes	0 (0)
No	128 (100)
MACE (%)	
Yes	24 (18.8)
No	104 (81.3)
Age (Years)	60.64 (38-72)
BMI (kg/m^2)	25.05 (21.71-32.60)
LVEF (%)	50.66 (38-67)
SYNTAX-I	18 ± 6.15
SYNTAX-II	28.07 ± 9.54
Creatinine	1,25 (0,44-3.69)
Ureum	38.22 (9-103)
Creatinine Clearance	72±28.8
GDP	159.21 (82-344)
GD2PP	198 (88-471)
HbA1c	8.1 (5.3-16.1)

Subjects were divided into two groups based on the SS-II: low–intermediate (≤27.7; n = 64) and high (>27.7; n = 64). As shown in Table 2, significant differences were observed between the groups in terms of age, COPD, left ventricular ejection fraction (LVEF), urea, creatinine, creatinine clearance (CrCl), and the incidence of MACE. Among the 128 study participants, 24 (18.8%) experienced MACE, including 2 patients (3.1%) in the low–intermediate SS-II group and 22 patients (34.4%) in the high SS-II group.

Table 2. Demographic and Clinical Characteristics of the Population Based on SS-II

Parameter	SS-II ≤27.7 (n=64)	SS-II >27.7 (n=64)	*p*-Value
Age (Years)	58.06 (40-70)	63.22 (38-72)	<0.001*
Sex, (%)			
Male	47 (73.4)	45 (70.3)	0.694
Female	17 (26.6)	19 (29.7)	
BMI (kg/m^2)	25.31(20.5-32.6)	25.11 (21-31.9)	0.423
Hypertension (%)			
Yes	31 (48.4)	28 (43.8)	0.595
No	33 (51.6)	36 (56.3)	
Dyslipidemia (%)			
Yes	35 (54.7)	37 (57.8)	0.722
No	29 (45.3)	27 (42.2)	
COPD			
Yes	14 (21.9)	32 (50)	<0.001*
No	50 (78.1)	32 (50)	
Smoker (%)			
Yes	35 (54.7)	31 (48.4)	0.479
No	29 (45.3)	33 (51.6)	
LVEF, (%)	54.56 (40-67)	47.36 (38-67)	<0.001*
Creatinine	1,14 (0,59-2,29)	1,37 (0,44-3.69)	0.002*
Ureum	32.83 (9-99)	43.61 (13-103)	0.003*
Creatinine Clearance	82.64±25.74	56.30 ± 25.82	0.001*
GDP	161.28 (89-344)	157.14 (83-315)	0.968
GD2PP	200.58 (88-471)	196.02 (88-410)	0.918
HbA1c	8.0 (5.3-16.1)	8.1 (5.7-13.3)	0.766
MACE (%)			
Yes	2 (3.1)	22 (34.4)	<0.001*
No	62 (96.9)	42 (65.6)	

Clinical outcomes

The cumulative incidence of clinical outcomes across patient groups is presented in Table 3. The incidence of MACE within one year after PCI was highest among patients with high SS-II values. Acute heart failure was the most frequent MACE and was predominantly observed in the high SS-II group (34.4%). Both mortality and acute heart failure were significantly associated with higher SS-II levels (p = 0.042 and p = 0.003, respectively).

Table 3. Clinical Outcomes Based on SS-II One Year After PCI

MACE	SS-II ≤27.7 (n=64)	SS-II > 27.7 (n=64)	*p*-Value
Cardiovascular Mortality	0 (0)	4 (6.3)	0.042
Acute Heart Failure	2 (3.1)	13 (20.3)	0.003
Cardiogenic Shock	0 (0)	3 (4.7)	0.080
Malignant arrhythmia	0 (0)	2 (3.1)	0.496
Stroke	0 (0)	2 (3.1)	0.496

After adjustment for confounding factors, all outcomes remained significantly associated with the SS-II (Table 4). Logistic regression analysis using a backward stepwise elimination method was performed to identify independent predictors. The analysis demonstrated that advanced age, reduced left ventricular ejection fraction (LVEF), impaired renal function (decreased creatinine clearance), and the presence of COPD were significantly associated with a higher incidence of MACE in this study population.

Table 4. Multivariate Analysis of SYNTAX Score II as a Risk Factor for MACE in CCS

Variables	B	P-value	OR	95% CI
Age	0.070	0.040	1.073	1.003-1.147
CrCl	-0.037	<0.001	0.964	0.944-0.983
COPD	1.655	0.002	5.235	1.850-6.812
LVEF	-0.129	<0.001	0.879	0.825-0.937

Survival and event-free outcomes

Event-free survival Kaplan-Meier curves stratified by SS-II are shown in Figure 1. In analyses stratified by the SS-II, those with a SS-II greater than 27.7 experienced a more rapid decline in survival. The risk of MACE in the high SS-II group (>27.7) was 5.5-fold higher compared with those with a score ≤27.7. This difference was statistically significant ($p < 0.001$).

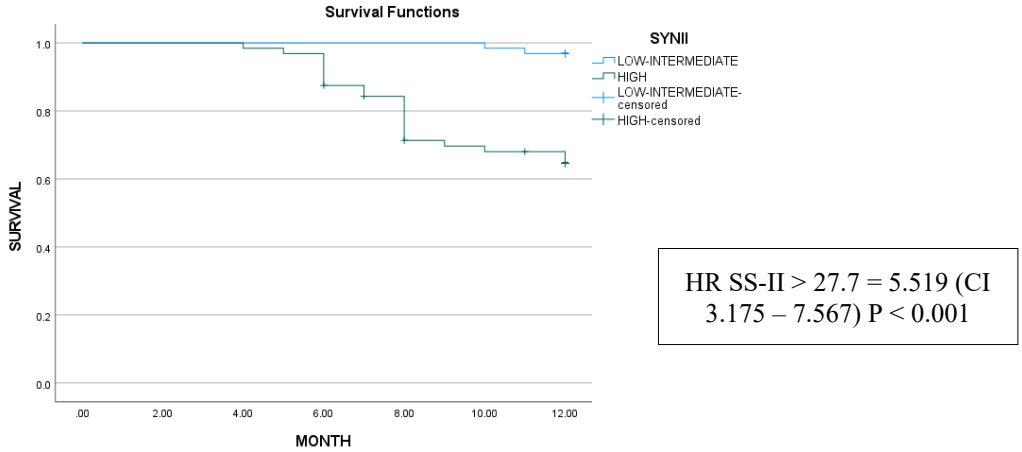

Figure 1. Kaplan–Meier Survival Curve for MACE Based on SYNTAX Score II

4. Discussion

This was a cohort study conducted at a single center involving patients who underwent PCI between June 2023 and August 2024. In-hospital and 12-month events and mortality were analyzed among 128 consecutive patients who met all inclusion criteria and provided informed consent. The SS-II, which incorporates both the anatomical complexity of coronary lesions and clinical high-risk parameters, was evaluated for all patients. In this study, male patients constituted the majority, with 92 (71.9%) compared to 36 female patients (28.1%). Hypertension, dyslipidemia, and smoking were observed in 59 (46.1%), 56 (43.8%), and 66 (51.6%) patients, respectively. Among all subjects, COPD was identified in 46 patients (35.9%).

The predominance of male patients in this study is consistent with findings by Papadopoulos et al. and Satthesh et al., who reported a higher prevalence of coronary artery disease in men. This may be attributed to the protective effects of estrogen in women, which enhances nitric oxide–mediated vasodilation and increases HDL levels. Conversely, greater visceral fat accumulation in men promotes insulin resistance, endothelial dysfunction, and inflammation, accelerating atherosclerotic plaque formation. Hypertension, dyslipidemia, and smoking were the most common risk factors identified in this study, consistent with the Framingham Study, which demonstrated that hypertension, hypercholesterolemia, and smoking are major determinants of cardiovascular disease [11,12,13,14].

In this study, the mean SS and SS-II were 18 ± 6.15 and 25.07 ± 9.54, respectively. The incidence of MACE was highest among patients with elevated SS-II values, with 22 patients (34.4%) in the high-score group. Acute heart failure was the most common MACE, observed in 13 patients with high SS-II scores. Both mortality and acute heart failure were significantly associated with higher SS-II levels ($p = 0.042$ and $p = 0.003$).

These findings are consistent with those of Samsul et al., who reported a higher incidence of MACE among patients with SS-II ≥33, and Sathessh et al., who found most patients had SS-II >27.7 ($p < 0.001$). Similarly, Yuksel et al. demonstrated that patients with higher SS-II scores had significantly greater rates of mortality, myocardial infarction, cardiogenic shock, stent thrombosis, repeat revascularization, and contrast-induced nephropathy ($p < 0.001$). Overall, higher SS-II values were consistently associated with worse clinical

outcomes and increased MACE incidence [11,13,15,16].

Logistic regression analysis in this study identified several significant predictors of MACE based on the SS-II score. Age (B=0.070; p=0.004; OR=1.073), creatinine clearance (B=0.037; p<0.001; OR=0.964), COPD (B=1.655; p=0.002; OR=5.235), and ejection fraction (B=−0.129; p<0.001; OR=0.879) were independently associated with MACE. Similarly, Samsul et al. reported that EF and CrCl were significant clinical predictors of adverse outcomes. Kaplan–Meier survival analysis over a one-year follow-up showed that patients with SS-II >27.7 experienced earlier and more frequent MACE compared with those with SS-II ≤27.7. The risk of MACE was 5.5-fold higher in the high-score group, with a statistically significant difference (p<0.001) [17,18,19].

These findings align with previous studies. Azzarelli et al. demonstrated significantly lower one-year MACE-free survival among patients with SS-II ≥29 compared to <29 (64.2% vs 87.2%; p=0.007). Likewise, Wang et al. found that after one year, MACE occurred in 12.5% of patients overall, with significantly higher rates in the highest SS-II tertile (22.1%) compared with intermediate (10.3%) and lowest tertiles (5.5%) (p<0.001). Together, these results highlight the prognostic value of the SS-II score in predicting long-term cardiovascular outcomes [20,21,5,22,23].

Study Limitation

This study has several limitations. Its retrospective design may introduce selection and information biases, despite the prospective collection of predictor and outcome variables. As a single-centre study, the findings may not be generalizable to wider populations, as they may partly reflect local practice patterns and healthcare infrastructure. The relatively small sample size may also limit statistical power and affect risk estimates. Additionally, the duration and control of DM-II were not assessed, although both may influence cardiovascular outcomes. Future studies should incorporate these factors to provide a more comprehensive evaluation of cardiovascular risk in CCS patients with diabetes.

5. Conclusion

In this cohort of 128 patients who underwent PCI, those with higher SS-II values exhibited a greater incidence of in-hospital and 12-month MACE. The SS-II demonstrated superior predictive value for both in-hospital and 12-month MACE. Routine assessment of SS-II during patient selection for PCI may facilitate improved risk stratification and help reduce mortality among high-risk patients by supporting the consideration of alternative revascularization strategies.

6. Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to privacy and ethical considerations, but are available from the corresponding author upon reasonable request.

7. Ethical Statement

This study received approval from the Research Ethics Committee of the Faculty of Medicine, USU (No.145-R/KEPK/USU/2025).

8. Author Contributions

All authors contributed to the design and implementation of the research, data analysis, and finalizing the manuscript.

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11. Conflict of Interest

Authors declares no conflict of interest.

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