Prognostic Value of Logistic Clinical Syntax Score in Coronary Bifurcation Lesions Treated with Double Stent Technique

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ABSTRACT

Introduction: In this study, we aimed to investigate the relationship between the preprocedural logistic clinical SYNTAX score (Log CSS) and major cardiovascular events (MACE) in patients with true bifurcation lesions who underwent revascularization with the double stent strategy.

Patients and Methods: A total of 233 non-ST elevation myocardial infarction (NSTEMI) patients who underwent revascularization with a double stent strategy were retrospectively included in the study. Anatomical SYNTAX score (SS) and log CSS were calculated. The patients were divided into two groups according to the cut-off value determined by ROC analysis. The prediction of two-year MACE with Log CSS was evaluated.

Results: MACE developed in 33.9% of patients with high Log CSS and 8.5% of patients with low Log CSS (p< 0.001). In the Kaplan-Meier survival analysis, the long-term survival of the high Log CSS patients was significantly lower than the low Log CSS group (Log-rank p< 0.001). In multivariate COX analyses, high Log CCS (HR= 3.781; 95% CI= 1.706-8.377; p= 0.001) was the strongest independent predictor of MACE.

Conclusion: Log CSS can be a simple and useful tool to predict the development of MACE in patients with true bifurcation lesions revascularized by percutaneous coronary intervention.

Key Words: Atherosclerosis; percutaneous coronary intervention

Çift Stent Tekniği ile Tedavi Edilen Koroner Bifurkasyon Lezyonlarında Lojistik Klinik Syntaks Skorunun Prognostik Değeri

ÖZET

Giriş: Bu çalışmada, çift stent stratejisi ile revaskülarizasyon uygulanan gerçek bifurkasyon lezyonu olan hastalarda işlem öncesi lojistik klinik SYNTAX skoru (Log CSS) ile majör kardiyovasküler olaylar (MACE) arasındaki ilişkiyi araştırmayı amaçladık.

Hastalar ve Yöntem: Mayıs 2011 ile Ekim 2019 tarihleri arasında çift stent stratejisi ile revaskülarizasyon uygulanan toplam 233 ST elevasyonsuz miyokard enfarktüsü (NSTEMI) hastası geriye dönük olarak çalışmaya dahil edildi. Anatomik SYNTAX skoru (SS) ve log CSS hesaplandı. Hastalar ROC analizi ile belirlenen cut-off değerine göre iki gruba ayrıldı. Log CSS> 6 olan hastalar yüksek Log CSS grubu (n= 56) ve Log CSS≤ 6 olanlar düşük Log CSS grubu (n= 177) olarak tanımlandı. Log CSS ile iki yıllık MACE tahmini değerlendirildi.

Bulgular: Yüksek Log CSS'li hastaların %33.9'unda ve düşük Log CSS'li hastaların %8.5'inde MACE gelişti (p< 0.001). Kaplan-Meier sağkalım analizinde, yüksek Log CSS hastalarının uzun vadeli sağkalımı, düşük Log CSS grubundan önemli ölçüde düşüktü (Log rank p< 0.001). Çok değişkenli COX analizlerinde, yüksek Log CCS (HR= 3.781; %95 GA= 1.706-8.377; p= 0.001), MACE'nin en güçlü bağımsız tahmincisiydi. Log CSS, anatomik SS'ye kıyasla iki yıllık MACE gelişimini tahmin etmede daha güçlüydü.

Sonuç: Log CSS, perkütan koroner girişimle revaskülarize edilen gerçek bifurkasyon lezyonu olan hastalarda MACE gelişimini öngörmek için basit ve kullanışlı bir araç olabilir.

Anahtar Kelimeler: Ateroskleroz; perkütan koroner girişim

Cite this article as: *Demirci G, Aslan S, Demir AR, Uygur B, Işık A, Arslan E, et al. Prognostic value of logistic clinical syntax score in coronary bifurcation lesions treated with double stent technique. Koşuyolu Heart J 2022;25(3):240-249.*

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Submitted: 10.05.2022
Accepted: 28.09.2022
Available Online Date: 01.12.2022

INTRODUCTION

Acute coronary syndrome patients undergoing percutaneous coronary intervention (PCI) procedures are at high risk for in-hospital and long-term adverse cardiovascular events (MACE) despite advances in stent technology and new techniques[1]. Coronary bifurcation lesions are one of the most difficult procedures in interventional cardiology. Coronary bifurcation lesions constitute approximately 15-20% of patients undergoing PCI. The complication rate of bifurcation lesions is high; however, the procedural success is low. They are complex lesions with higher rates of stent thrombosis and restenosis in follow-ups[2-4]. Therefore, various scoring techniques have been developed to predict mortality and morbidity in patients after PCI. The SYNTAX score (SS) is a scoring system that is used to determine the most appropriate revascularization strategy between PCI and coronary artery bypass grafting (CABG), based on the complexity and severity of coronary lesions[5,6]. It has been recommended in both European and American revascularization guidelines[7,8]. It has been found to predict accurately the risk of adverse events in the long-term outcome of patients undergoing PCI[9]. However, SS is only an anatomy-based tool for quantitatively assessing and grading the angiographic features of coronary lesions, which significantly limits the accuracy of long-term mortality or major adverse cardiac events[10]. To overcome this limitation and improve risk stratification, the Logistics Clinical SYNTAX Score (Log CSS), a combined risk scoring system including clinical (age, creatinine clearance, left ventricular ejection fraction (LVEF)) and angiographic parameters (SS), has been developed[11].

Our aim was to evaluate the relationship between Log CSS and MACE in patients with true bifurcation lesions who underwent double stent revascularization, and to compare Log CSS and SS in terms of MACE prediction in this patient group.

PATIENTS and METHODS

Study Population and Methods

Our study retrospectively included 233 non-ST elevation myocardial infarction (NSTEMI) patients who underwent revascularization with a double stent strategy in our hospital between May 2011 and October 2019.

Inclusion criteria were main vessel reference diameter ≥2.5 mm, lateral vessel reference diameter ≥2.25 mm, 1.1.1 or 0.11 or 1.0.1 lesions according to Medina classification, and revascularization with two stent strategies. Cardiogenic shock, cardiopulmonary resuscitation, severe left ventricular systolic dysfunction (LVEF< 30%), intolerance to antiplatelet therapy, discontinuation of antiplatelet therapy for any reason, presence of intraluminal thrombus, severe calcification and severe tortuosity were the exclusion criteria.

The study was approved by the ethics committee of our institution and was performed in accordance with the requirements of the Declaration of Helsinki. (Date: 08/05/2019, Decision No: A-02).

SYNTAX and Logistic Clinical SYNTAX Score

Two interventional cardiologists, blinded to the study protocol and patient characteristics, evaluated the angiographic images of all patients. The SYNTAX (synergy between TAXUS and PCI and cardiac examination) score was calculated using the SYNTAX website. The SS for each patient was calculated by using the SS algorithm for all coronary lesions with more than 50% stenosis in vessels greater than 1.5 mm in diameter; the culprit lesion was calculated retrospectively by considering angiographic images of the infarct-related artery before any intervention. The SS was combined with a simple clinical risk score including age, ejection fraction, and creatinine clearance to generate log CSS. The Log CSS core model used in this study was calculated according to the formula developed by Farooq et al[11]. Log CSS calculation criteria are summarized in Figure 1. The intra- and inter-observer variability for all measurements is less than 5%.

Clinical Characteristics and Follow-up

The baseline demographic, clinical, and laboratory parameters of the patients were recorded retrospectively, and all-cause mortality, cardiac mortality, stroke, myocardial infarction (MI), target vessel revascularization (TVR), target lesion revascularization (TLR) were scanned in patients who were followed up for a median of 24.0 (14.8-32.0) months after PCI. The combination of these endpoints was considered as MACE.

Telephone and mobile phone calls, electronic data, and outpatient clinics were used to follow up on the patients. The time from the index procedure date to the end of the follow-up date or the development of any MACE is referred to as clinical follow-up.

Statistical Analysis

Statistical analysis of the study was performed with the SPSS Version 24.0 software (SPSS Inc., Chicago, Illinois, USA). Whether the variables show a normal distribution was evaluated by using visual (histograms, probability curves) and analytical methods (Kolmogorov-Smirnov's and Shapiro-Wilk). Normally distributed numerical variables were expressed as mean ± standard deviation (SD), non-normally distributed numerical variables were expressed as median (interquartile range), and categorical variables were expressed as percent (%). ROC (Receiver Operating Characteristic) curve and Youden index [max (Sensitivity + Selectivity - 1)] were

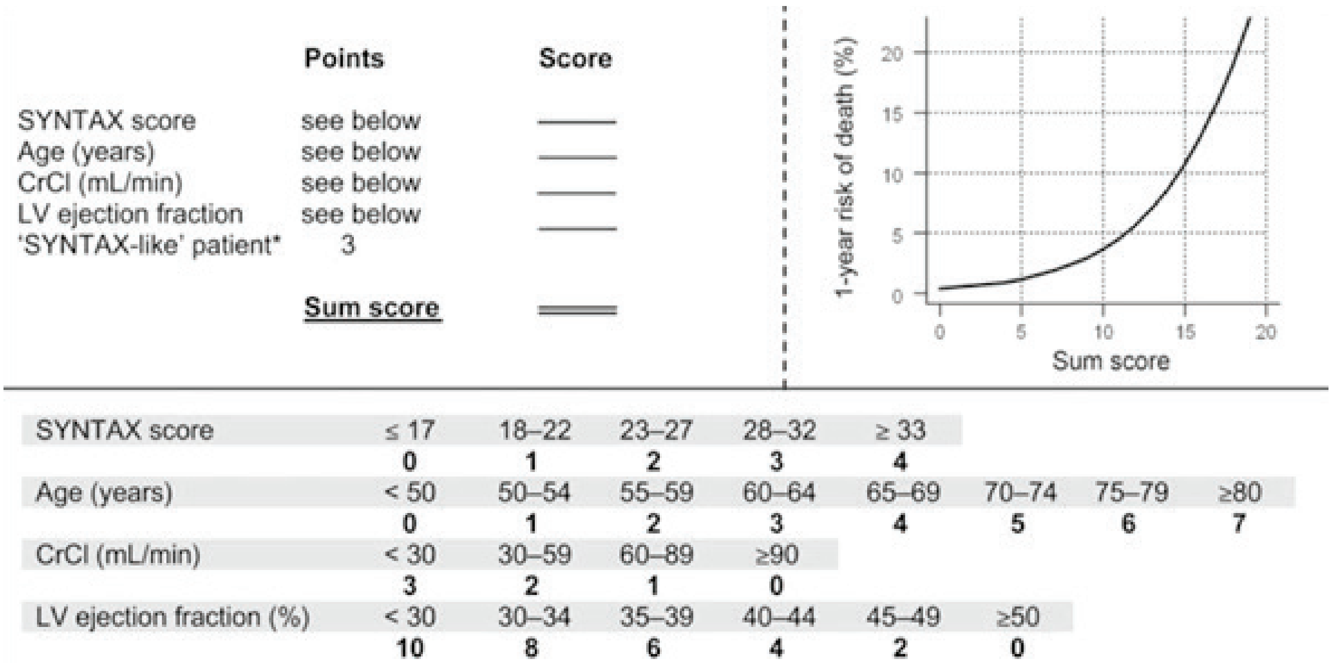


Figure 1. Log CSS calculation criteria.
CrCl: Creatinin clearence, LV: Left ventricle.

used to determine the log CSS predictive value that best detects the presence of MACE, and an area under the ROC curve that was greater than 0.5 was considered significant.

Statistical analysis of numerical variables between groups was performed with Student's t-test or Mann-Whitney U test, and analysis of categorical variables was performed with Chi-square or Fisher's exact test. A univariable and multivariable Cox proportional hazards model was used to calculate hazard ratios (HRs) and 95% confidence intervals (95% CI) for MACE. Event-free survival curves were constructed using the Kaplan-Meier method and compared using the log-rank test. Throughout the present study, a p-value of <0.05 was considered significant.

RESULTS

The study included 233 patients (mean age= 59.5 ± 11.1 years) and 77.7% (181/233) of the study population was male. The patients were divided into two groups according to the cut-off value determined by the ROC curve and the Youden index. Patients with a log CSS value of >6 were included in the high log CSS group (n= 56) and those with a log CSS value of ≤6 in the low log CSS group (n= 177). As expected, patients in the high log CSS group had significantly higher age and SS, and lower GFR and LVEF. Moreover, the high log CSS group had a lower percentage of male patients (67.9% vs. 80.8%, p= 0.043) and higher rates of DM (58.9% vs. 32.2%, p< 0.001) and HT (62.5% vs. 42%, p= 0.008) (Table 1).

The comparison of the two groups in terms of the endpoints constituting MACE after a two-year follow-up was shown in Figure 2. Although MI, stroke, TLR, and TVR were detected more in the high log CSS group, they could not reach statistical significance. CV mortality and all-cause mortality rates were significantly higher in the high log CSS group. As a result, patients in the high log CSS group (33.9%) experienced a higher rate of MACE than patients in the low log CSS group (8.5%) (p< 0.001).

Initially, univariable COX regression analysis was performed to identify effective predictors of MACE development over time in patients revascularized with the double stent strategy. Significant (p< 0.1) parameters in this analysis - PCI history, cerebrovascular disease history, triglyceride level, bifurcation location, POT, final kissing, contrast media volume, and log CSS- were subjected to multivariable analysis. As a result of the multivariable analysis, high log CCS (HR= 3.781, 95% CI= 1.706-8.377, p= 0.001) and final kissing (HR= 0.241, 95% CI= 0.059-0.991, p= 0.049) were determined as independent predictors of MACE (Table 2). As shown in Table 3, patients were categorized based on different stenting techniques used for bifurcation lesion revascularization, to determine MACE predictors. A history of cerebrovascular disease and no final kissing were found to be associated with MACE in the TAP technique, high log CSS and no final kissing were associated with MACE in the culotte technique, and high log CSS, previous PCI, and the volume of contrast media were associated with MACE in the crush technique.

Table 1. Comparison of characteristics of study patients with Log CSS				
	Total n= 233	**Log CSS≤ 6 n= 177**	**Log CSS> 6 n= 56**	**p**
Age, years	59.5 ± 11.1	56.0 ± 8.9	70.3 ± 10.4	<0.001
Male, n (%)	181 (77.7)	143 (80.8)	38 (67.9)	0.043
Diabetes mellitus, n (%)	90 (38.6)	57 (32.2)	33 (58.9)	<0.001
Hypertension, n (%)	109 (47.0)	74 (42.0)	35 (62.5)	0.008
Hyperlipidemia, n (%)	102 (43.8)	82 (46.3)	20 (35.7)	0.163
Prior MI, n (%)	77 (33.0)	54 (30.5)	23 (41.1)	0.143
Prior PCI, n (%)	72 (30.9)	52 (29.4)	20 (35.7)	0.371
Peripheral artery disease, n (%)	16 (6.9)	8 (4.5)	8 (14.3)	0.028
Carotid artery disease, n (%)	13 (5.6)	5 (2.8)	8 (14.3)	0.003
Cerebrovascular disease, n (%)	1 (0.4)	0 (0.0)	1 (1.8)	0.240
Chronic kidney disease, n (%)	2 (0.9)	2 (1.1)	0 (0.0)	1.0
Atrial fibrillation, n (%)	8 (3.4)	4 (2.3)	4 (7.1)	0.097
LVEF, %	52.8 ± 10.1	56.5 ± 6.8	40.9 ± 9.7	<0.001
Laboratory data				
Hematocrit (%)	40.6 ± 5.3	41.2 ± 4.9	38.6 ± 5.8	0.002
White blood cells (10^3/uL)	9.55 ± 2.89	9.64 ± 2.89	9.29 ± 2.90	0.432
Platelet (10^3/uL)	260 ± 62	263 ± 58	250 ± 73	0.173
Creatinine (mg/dL)	0.86 (0.72-0.97)	0.85 (0.71-0.95)	0.89 (0.79-1.01)	0.027
GFR, mL/min	95.7 ± 25.4	99.3 ± 24.3	84.3 ± 25.8	<0.001
Total cholesterol (mg/dL)	189 ± 50	191 ± 49	182 ± 51	
LDL-C (mg/dL)	107 (84-133)	109 (89-134)	107 (67-128)	0.311
HDL-C (mg/dL)	44 ± 11	43 ± 10	46 ± 12	0.193
Triglyceride (mg/dL)	152 (100-230)	162 (102-246)	145 (96-183)	0.182
SYNTAX score	15.7±4.6	14.6 ± 3.6	18.9 ± 5.8	<0.001
Bifurcation location				<0.001
LAD-CX, n (%)	16 (6.9)	3 (1.7)	13 (23.2)	
LAD-Diagonal, n (%)	135 (57.9)	103 (58.2)	32 (57.1)	
CX-OM, n (%)	74 (31.8)	63 (35.6)	11 (19.6)	
PDA-PLA, n (%)	8 (7.0)	8 (4.5)	0 (0.0)	
Stenting strategy				0.185
T-stenting, n (%)	93 (39.9)	76 (42.9)	17 (30.4)	
Culotte stenting, n (%)	57 (24.5)	43 (24.3)	14 (25.0)	
Crush stenting, n (%)	83 (35.6)	58 (32.8)	25 (44.6)	
Bifurcation angle> 70° n (%)	91 (39.1)	75 (42.4)	16 (28.6)	0.065
Main branch lesion length (mm)	19.9 ± 6.5	20.0 ± 6.7	19.7 ± 5.7	0.813
Side branch lesion length (mm)	12.6 ± 5.6	12.5 ± 5.4	12.9 ± 6.2	0.715
Main branch vessel diameter (mm)	2.88 ± 0.29	2.86 ± 0.27	2.95 ± 0.33	0.043
Side branch vessel diameter (mm)	2.61 ± 0.23	2.59 ± 0.22	2.66 ± 0.25	0.044

Table 1. Comparison of characteristics of study patients with Log CSS (continued)

	Total n= 233	Log CSS≤ 6 n= 177	Log CSS> 6 n= 56	p
Main branch stent length (mm)	25.3 ± 6.5	25.4 ± 6.7	25.0 ± 6.0	0.631
Side branch stent length (mm)	19.3 ± 5.0	19.4 ± 5.1	19.0 ± 4.8	0.674
Main branch stent size (mm)	2.88 ± 0.29	2.86 ± 0.27	2.95 ± 0.33	0.040
Side branch stent size (mm)	2.61 ± 0.23	2.60 ± 0.23	2.66 ± 0.25	0.066
Predilatation, n (%)	188 (80.7)	140 (79.1)	48 (85.7)	0.274
POT, n (%)	197 (84.5)	152 (85.9)	45 (80.4)	0.319
Final kissing, n (%)	225 (96.6)	171 (96.6)	54 (96.4)	1.0
Procedural time (min)	70 (55-93)	68 (55-90)	75 (55-104)	0.363
Fluoroscopy time (min)	23 (18-35)	23 (17-33)	28 (18-39)	0.116
Contrast volume (mL)	329 ± 109	323 ± 106	347 ± 119	0.154

Data are presented as percentage, mean ± standard deviation or median (interquartile range). CSS: Clinical syntax score, MI: Myocardial infarction, PCI: Percutaneous coronary intervention, LVEF: Left ventricular ejection fraction, GFR: Glomerular filtration rate, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, LAD: Left anterior descending artery, LCx: Left circumflex artery, OM: Obtuse marginal artery, PDA: Posterior descending artery, PLA: Posterolateral artery, POT: Proximal optimization technique.

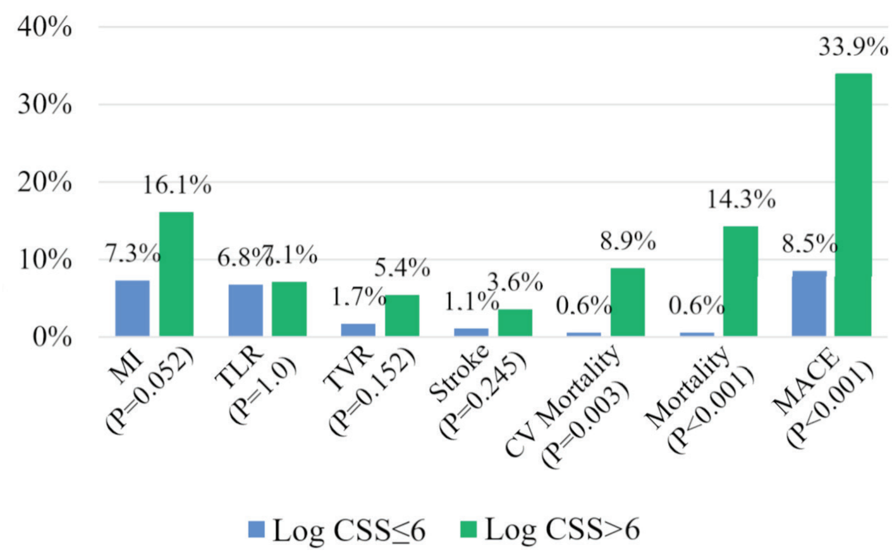


Figure 2. Comparison of two-year clinical outcomes of high and low log CSS groups.

MI: Miyocardial infarction, TLR: Target lesion revascularization, TVR: Target vessel revascularization, CV: Cardiovascular, MACE: Major adversc cardiovascular event.

In Figure 3, Kaplan-Meier cumulative survival curves for MACE were observed in patients categorized according to log CCS. Kaplan-Meier curves showed that the high log CSS group had a higher incidence of MACE compared to the low log CSS group (Log-rang test, $p< 0.001$).

ROC curves were drawn for both scores to compare log CSS and SS in terms of power to detect MACE development (Figure 4). The AUC value obtained with log CSS was higher than that obtained with SS (0.710 vs 0.610). A log CSS value greater than 6 could detect MACE development with a sensitivity of 55.9% and a specificity of 81.4%.

DISCUSSION

The main findings of our study are the following: 1) 14.4% of the entire patient group developed MACE, 2) MACE development was statistically higher in the high log CSS group than the low log CSS group, 3) long-term survival of high log CSS patients was significantly lower than the low-log CSS group, 4) high log CCS was the strongest independent predictor of MACE, 5) log CSS is superior to anatomical SS in predicting two-year MACE development.

Table 2. Univariable and multivariable logistic regression analyzes for the development of MACE

	Univariate analysis		Multivariate analysis	
Parameters	**HR (95% CI)**	**p**	**HR (95% CI)**	**p**
Prior PCI	1.864 (0.946-3.676)	0.072	1.966 (0.954-4.050)	0.067
CVD	13.650 (1.810-103.0)	0.011	7.401 (0.771-71.041)	0.083
Triglyceride	1.002 (1.000-1.004)	0.095	1.002 (1.000-1.004)	0.131
Log CSS> 6	5.102 (2.582-10.079)	<0.001	3.781 (1.706-8.377)	0.001
Bifurcation location		0.019		0.144
LAD-Diagonal*	0.386 (0.156-0.952)	0.039	1.826 (0.564-5.912)	0.315
CX-OM*	0.148 (0.045-0.485)	0.002	0.575 (0.138-2.390)	0.446
PDA-PLA*	<0.001 (<0.001->1000)	0.974	<0.001 (<0.001->1000)	0.976
POT	0.534 (0.254-1.120)	0.097	0.586 (0.256-1.343)	0.207
Final kissing	0.314 (0.096-1.032)	0.056	0.241 (0.059-0.991)	0.049
Contrast volume	1.003 (1.000-1.006)	0.034	1.003 (1.000-1.006)	0.054

HR: Hazard ratio, CI: Confidence interval, PCI: Percutaneous coronary intervention, CVD: Cerebrovascular disease, CSS: Clinical syntax score, LAD: Left anterior descending artery, LCx: Left circumflex artery, OM: Obtuse marginal artery, PDA: Posterior descending artery, PLA: Posterolateral artery, POT: Proximal optimization technique.
* Compared to LAD-LCx.

Table 3. Multivariable logistic regression analysis for the development of MACE in different stenting strategies

	Multivariate analysis		
	TAP		
	HR	**95% CI**	**p**
Peripheral artery disease	1.371	0.208-9.053	0.743
Carotid artery disease	3.935	0.597-25.937	0.154
Cerebrovascular disease	18.070	1.371-238.18	0.028
Triglyceride	1.003	0.999-1.006	0.123
Log CSS> 6	2.229	0.471-10.539	0.312
Final kissing	0.056	0.006-0.512	0.011
	Culotte		
	HR	**95% CI**	**p**
Log CSS> 6	14.287	1.590-128.37	0.018
Final kissing	0.030	0.002-0.516	0.016
	Crush		
	HR	**95% CI**	**p**
Prior PCI	3.753	1.272-11.068	0.017
Hematocrit	0.949	0.851-1.058	0.348
Log CSS> 6	6.067	1.921-19.165	0.002
Number of affected vessels	1.772	0.906-3.463	0.095
Contrast volume	1.005	1.001-1.010	0.014

Variable with p< 0.1 in univariate analysis were included to multivariate analysis. HR: Hazard ratio, CI: Confidence interval, CSS: Clinical syntax score, PCI: Percutaneous coronary intervention, TAP: t stent and protrusion, MACE: Major adversc cardiovascular event.

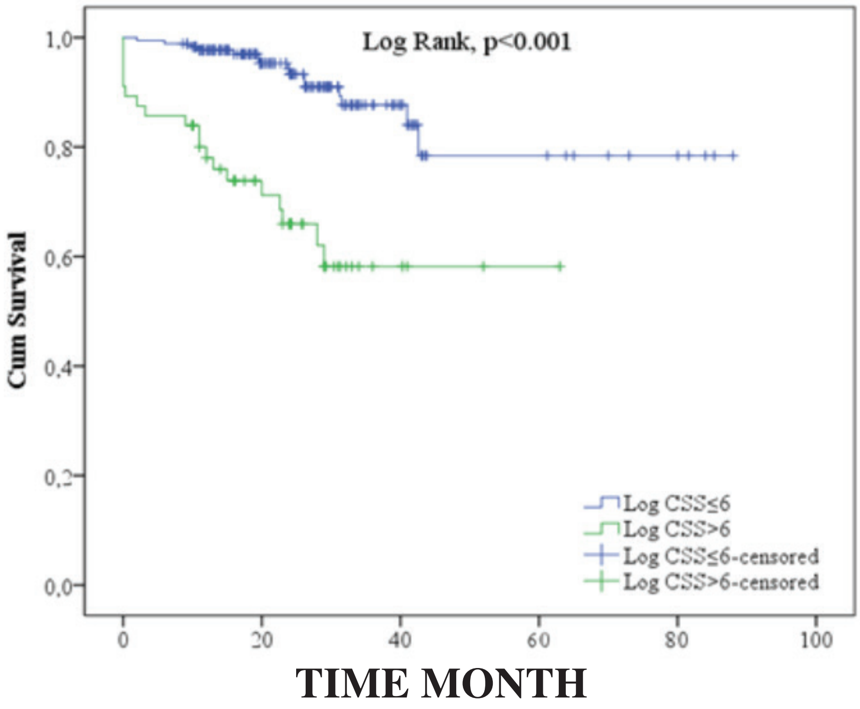
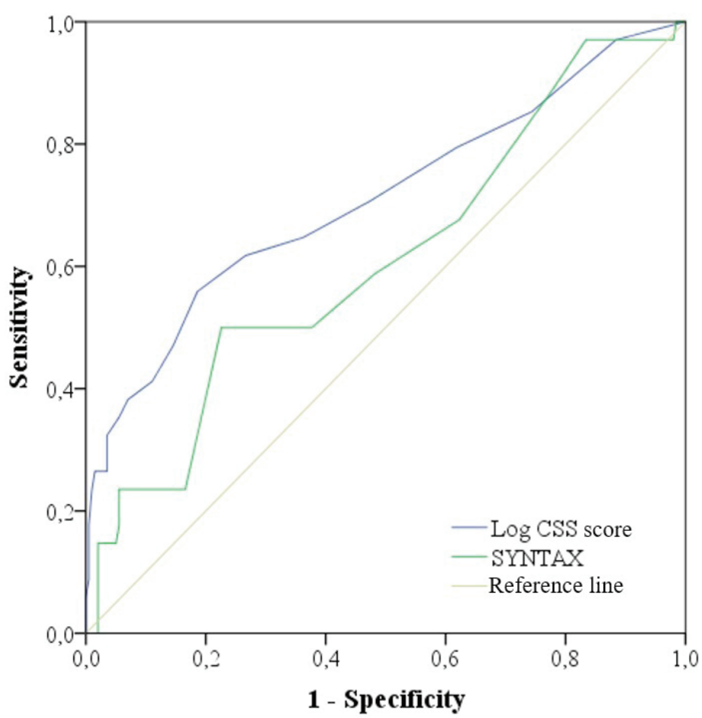


Figure 3. Kaplan-Meier curves for survival at two-year follow-up after index procedure according to whether log CCS is high or low.



	AUC	95% CI	P-value
Log CSS	0.710	0.603-0.817	<0.001
SYNTAX score	0.610	0.503-0.717	0.040

Figure 4. Long-term risk prediction with ROC curve of Log CCS and SS.

CSS: Clinical SYNTAX score, AUC: Area under the curve, CI: Confidence interval.

Patient selection plays an important role in treatment decisions, and the identification of potential risks is an important part of the decision-making process. Risk classification score models are regarded as effective methods of predicting adverse events following procedures and useful tools for assisting patients and physicians in selecting the best treatment strategy(12,13).

The SYNTAX score is an angiography-based tool created during the design of the SYNTAX trial to quantify the extent and complexity of coronary artery disease and to determine the most appropriate revascularization strategy between PCI and CABG(5,6). This score has been shown to predict PCI outcomes(14-16) and has been included in European and American revascularization guidelines to assist in the appropriate selection of revascularization strategy(17,18).

However, SS is only an anatomy-based tool for quantitatively assessing and grading the angiographic features of coronary lesions, which significantly limits the accuracy of long-term mortality or major adverse cardiac events. There may be several reasons for this limitation. First of all, this can be explained by the association of anatomical complexity (calcification, tortuosity, lesion length, etc.) evaluated in SS with in-hospital or early-stage adverse cardiac events (target vessel revascularization, stent thrombosis, myocardial infarction). Secondly, sometimes patients with equivalent anatomic SS can have very different outcomes after revascularization, depending on the presence of comorbidities. Therefore, it may not be sufficient to predict two-year mortality or MACE. To overcome this limitation, new scores including clinical and angiographic variables have been developed to predict mortality and adverse outcomes with higher accuracy when compared to risk scores based on anatomy alone in patients undergoing PCI or CABG. Comorbidities derived from surgical scores such as ACEF(19,20) or EuroSCORE24(21) were included in anatomical SS. Following this, log CSS was developed by combining anatomical SS with clinical factors selected according to logistic regression coefficients(11,22,23). First introduced by Farooq et al., log CSS(11) consists of both clinical (age, creatinine, LVEF) and anatomical (SS) parameters. It has been reported that log CSS is more accurate than SS in estimating one-year and three-year cardiovascular mortality after PCI(11,22). Kawashima et al. found log CSS to be a significant predictor of two-year mortality after PCI in STEMI patients(24). Consistent with the literature, our study showed that log CSS, which reflects the logistic evolution of SYNTAX-derived scores, has a superior ability to predict two-year MACE development compared to anatomical SS. In addition, Uygur et al. found that log CSS was an independent predictor of in-hospital mortality in patients with ST-elevation myocardial infarction who underwent emergency coronary artery bypass graft surgery(25). Öztürk et al. used log CSS to predict Saphenous Vein Graft failure in patients undergoing coronary artery bypass grafting(26).

Coronary bifurcation lesions account for 15% to 20% of all percutaneous coronary interventions and are among the most challenging lesions in interventional cardiology in terms of both procedural success and long-term clinical outcomes (27). Treatment of bifurcation coronary lesions remains a challenging area where best practice has not yet been fully established. Short-term complications such as periprocedural myocardial infarction and long-term complications such as in-stent restenosis and stent thrombosis are higher in patients with bifurcation lesions(28). The use of drug-eluting stents in percutaneous coronary intervention has improved the short- and long-term outcomes of bifurcation lesion treatment(29). While current guidelines recommend the provisional technique as the preferred approach, the double stent strategy remains a viable option for patients with complex true bifurcation lesions. However, the optimal double-stent strategy for the treatment of this complex subset of lesions remains a matter of technical debate, and there is limited information on long-term clinical outcomes(30). There is no clear evidence that a specific double stenting technique is superior to others in improving clinical outcomes after coronary bifurcation intervention(31). The presence of diabetes, the final kissing balloon, the use of non-compliant balloons, and pre-dilatation were all predictive of re-revascularization(31). There are few studies evaluating the prognostic value of SS in bifurcation patients. Pillai et al. investigated the effect of SS 1 and SS 2 scores on MACE following stenting in 103 patients with unprotected left main bifurcation disease. As a result of the study, they showed that both scorings were effective on target lesion revascularization and mortality. In this sense, SS 1 was found to be superior to SS 2(32). In our study, SS was also a predictor of MACE in patients with bifurcation lesions treated with a double stent strategy, but Log CSS performed better than SS. Furthermore, in the subgroup analysis performed according to stenting techniques, it was an independent predictor of MACE in log CSS, Crush, and Culotte techniques, but not in the TAP technique. We think that this result is due to the fact that the TAP technique is less complex, and the procedure duration is shorter than the other two methods(33). Based on this finding, we believe that in patients with high Log CSS, it would be more appropriate to intervene in a bifurcation lesion with the TAP technique as a double stent strategy.

To the best of our knowledge, no data have been published regarding the possible relationship between log CSS and MACE in coronary bifurcation lesions undergoing PCI with a double stent strategy. Therefore, our study is the first to evaluate the predictive value of log CSS in patients who underwent a double stent strategy for coronary bifurcation lesions.

Limitations

This study was designed as a retrospective and single-center study. Large randomized clinical studies are needed. The choice of treatment strategy, stent type, and stenting technique was at the discretion of the operator. The stents used in our study were first-generation; the exclusive use of first-generation DES may have affected clinical outcomes.

CONCLUSION

Our study reveals that log CSS, a new version of anatomical SS enhanced with clinical parameters, has a predictive value for clinical endpoints (all-cause mortality, re-revascularization, and hospitalization) in patients with coronary bifurcation lesions treated with the double-stent strategy. Log CSS appears to have better predictive value in estimating two-year MACE compared to SS and allows for a personalized risk assessment of patients undergoing PCI. It should be used for long-term risk stratification of patients undergoing PCI. Large prospective studies are required to further evaluate our findings.

Ethics Committee Approval: The study was approved by the Ethics Committee of İstanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital and was performed in accordance with the requirements of the Declaration of Helsinki. (Date: 08/05/2019, Decision No: A-02).

Informed Consent: This is retrospective study, we could not obtain written informed consent from the participants.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept/Design - SA, ME, GD; Analysis/Interpretation - AD, GD; Data Collection - EA, AI, GD; Writing - BU, GD; Critical Revision - BU, EA, GD; Final Approval - ME, GD; Statistical Analysis - AD, GD; Overall Responsibility - GD.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declare that this study has received no financial support.

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