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Predictive Value of Shock Index for In-hospital Mortality among Patients with Multivessel Disease Diagnosed with Acute Coronary Syndrome

Şok İndeksinin Çoklu Damar Hastalığı Saptanan Akut Koroner Sendrom Hastalarındaki Hastane İçi Mortaliteyi Öngördürücü Değeri

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Abstract

Objectives: To evaluate the association between shock index (SI) and in-hospital mortality in patients with multivessel disease in acute coronary syndrome.

Materials and Methods: A total of 623 patients with multivessel disease who were diagnosed with acute coronary syndrome and underwent coronary angiography with revascularization therapy via primary percutaneous coronary intervention or coronary artery bypass surgery were enrolled in our study. The SI was calculated by dividing the heart rate by the systolic blood pressure.

Results: The deceased patients had significantly lower systolic blood pressure and higher heart rate than those without mortality (p<0.001 for all). In multivariable cox regression analysis, age, lower left ventricular ejection fraction, higher anatomical SYNTAX score, and SI were independent predictors of in-hospital mortality. The receiver operating characteristic curve analysis exhibited that SI had adequate discriminative power for predicting in-hospital mortality (area under the curve: 0.711, 95% confidence interval: 0.632-0.789, p<0.001).

Conclusion: The shock index was found to be an independent predictor of mortality in patients with multivessel disease diagnosed with acute coronary syndrome.

Keywords: Shock index, acute coronary syndrome, mortality

Öz

Amaç: Biz bu çalışmamızda akut koroner sendromlu olgularda çok damar hastalığı saptanan durumlar da şok indeksinin hastane içi mortalite üzerine olan etkisini değerlendirmek istedik.

Yöntem ve Gereçler: Çalışmamıza akut koroner sendrom tanısı alan, çok damar hastalığı saptanan ve koroner anjiyografi ve primer perkütan koroner girişim ya da koroner arter by-pass cerrahisi yolu ile tedavi edilen 623 hasta dahil edildi. Şok indeksi kalp hızını sistolik kan basıncına bölerek hesaplandı.

Bulgular: Mortalite saptanan olgularda istatistiksel olarak kan basıncı daha düşüktü ve kalp hızı diğer gruba kıyasla daha yüksekti (p<0,001). Çok değişkenli Cox regresyonan alizinde yaş, düşük sol ventrikül ejeksiyon fraksiyonu, yüksek anatomik SYNTAX skoru ve şok indeksi hastane içi ölüm için öngördürücü olarak bulundu. Alıcı işletim karakteristik eğrisi analizinde şok indeksinin yeterli derecede mortalite öngördürücü istatistiksel gücü olduğu tesbit edildi (eğri altındaki alan: 0,711, %95 güven aralığı: 0,632-0,789, p<0,001).

Sonuç: Şok indeksi akut koroner sendromlu çok damar hastalığı olgularında mortalite öngördürücüsü olarak saptanmıştır.

Anahtar Kelimeler: Şok indeks, akut koroner sendrom, mortalite

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INTRODUCTION

In recent years, despite a decline in the incidence of multivessel coronary artery disease (MVD) among patients with acute coronary syndrome (ACS), it remains a prevalent condition. MVD is observed in approximately 40-66% of patients with ACS who undergo coronary angiography (1-4). The presence of MVD negatively affects the success of revascularization and cardiovascular outcomes, making it highly significant for patients with ACS (3-5). Therefore, numerous studies have been conducted on revascularization strategies and timing for this patient group, one of the most well-known being the Synergy between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (SYNTAX) trial (6-9).

MVD represents a significant portion of ACS and is frequently encountered in clinical practice. Therefore, predicting adverse cardiovascular outcomes in this patient group is of particular importance. One of the most important determinants of mortality in patients with MVD is the treatment modality. Although there is conflicting evidence regarding the superiority of routine complete revascularization versus culprit lesion-only intervention, it has been clearly demonstrated that both surgical and percutaneous revascularization provide a significant advantage over medical treatment (10-12). Another variable associated with adverse cardiovascular outcomes is the SYNTAX score. Serruys et al. (9) revealed that patients treated with percutaneous coronary intervention (PCI) and with a high SYNTAX score experienced significantly higher rates of major cardiovascular and cerebrovascular events.

The shock index (SI), calculated by dividing the heart rate by the systolic blood pressure, is a highly useful clinical variable for predicting mortality in patients with ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI) (13,14). Additionally, a meta-analysis has shown that the SI predicts in-hospital mortality as well as short- and long-term adverse outcomes in patients with acute myocardial infarction (MI) (15). The SI, an inexpensive, quickly calculated, risk-free, and reproducible parameter that does not require any laboratory values, appears to be a beneficial metric for identifying patients at high risk for mortality in ACS patients. Considering that nearly 50% of ACS cases involve MVD, the predictive significance of the SI specifically in this patient population has yet to be clearly established. Our aim was to evaluate the association between SI and in-hospital mortality in patients with MVD who were admitted for ACS and treated with PCI or surgical revascularisation.

MATERIAL AND METHODS

The medical records of consecutive patients admitted to the Department of Cardiology of University of Health Sciences Turkey, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital and Ataşehir Memorial Hospital from January 2015 to December 2020 were reviewed. Patients with multivessel disease who were diagnosed with ACS and underwent coronary angiography with revascularization therapy via primary PCI or coronary artery bypass surgery were recruited in our study. ACS in American College of Cardiology/American Heart Association guidelines were used to diagnose ACS. Acute chest pain or overwhelming shortness of breath with persistent ST-elevation is suggestive of STEMI in patients with true posterior MI (1). Patients with new-onset symptoms without persistent ST-segment elevation on ECG with cardiac troponin increase higher than normal limits were diagnosed as NSTEMI, whereas patients without any of the above-mentioned features with new-onset symptoms suggestive of ischemia were diagnosed as unstable angina pectoris (1). All patients underwent invasive evaluation in line with recent guidelines (1).

The baseline clinical and demographic features of patients, including body mass index; hypertension (HT); diabetes mellitus (DM); premature family history; hyperlipidemia; smoking and vascular disease, defined as a history of prior MI, peripheral arterial disease (PAD), and ischemic stroke or transient ischemic attack due to thromboembolism in the carotid or vertebral arteries, were obtained. PAD was defined as atherosclerotic disease in the arteries other than the coronaries in conjunction with exercise-related claudication, revascularization therapies, reduced or absent pulsation, amputation, or angiographic stenosis of >50%. Fasting blood glucose levels >125 mg/dL or current use of antidiabetic medications were defined as DM. Resting blood pressure >140/90 mmHg on at least two measurements or using antihypertensive pharmacologic treatment was defined as HT. The National Cholesterol Education Program-3 recommendations were used to define hyperlipidemia. The current cigarette smoking status was defined as smoking more than 10 cigarettes per day for at least 1 year without an attempt to be quit. The presence of heart disease or sudden cardiac death in a first-degree relative male 55 years old or in a female 65 years old was indicated as a positive family history. Patients with a left ventricular ejection fraction (LVEF) of 40% and associated symptoms were defined as those with congestive heart failure.

Our data were obtained after carefully evaluating 998 patient's record by using our database. A total of 623 patients were recruited after the final evaluation. Patients with single-vessel disease (n=246), only side branch disease (n=42), no significant coronary artery disease or other evident causes of coronary pain such as significant myocardial bridging or diffuse coronary spasm during angiography (n=17), malignancy (n=10), active infection (n=9), end- stage renal disease or receiving hemodialysis (n=19), and any missing information (n=32) were excluded from the study.

Vital signs, including blood pressure and heart rate, were obtained from recorded data at admission. The SI was calculated using the following formula: heart rate (bpm)/systolic blood pressure (mmHg). Blood glucose, creatinine, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglyceride levels were determined according to the admission blood samples. LVEF was measured using the modified Simpson's method in the apical 4- and 2-chamber views in both end-diastole and end-systole.

Two experienced interventional cardiologists blinded to the angiographic views of our study and patient data. The degree of stenosis that decreased the luminal diameter by more than 50% in the left main coronary artery (LMCA), left anterior descending artery, left circumflex coronary artery, and right coronary artery was defined as CAD. Quantitative evaluation of angiographic stenosis was performed using the anatomical SYNTAX score 1 and the downloaded version from "www.syntaxscore.com". Two groups have been exhibited based on the occurrence of in-hospital mortality.

In-hospital mortality, including all-cause mortality during hospitalization, was the primary endpoint of the study. Mortality information was obtained from the national death notification system and hospital records. Our study protocol was approved by the University of Health Sciences Turkey, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital Ethics Committee (number: E-28001928-604.01-263765499, date: 27.12.2024). Due to the retrospective nature of the study, informed consent was waived.

Statistical Analysis

Means ± standard deviation are used for continuous variables with normal distribution, and median interquartile ranges are used if there are no normal distribution. The percentages are used to evaluate the categorical variables. Categorical variables were compared using the chi-square (χ^2) test. The Kolmogorov-Smirnov test was used to determine whether the variables were distributed normally. The choice of tests was the Student's t-test or Mann-Whitney U test to compare continuous variables between groups, according to whether they were normally distributed or not. Variables indicating in-hospital mortality with a p-value <0.05 according to univariate analysis were included in the multivariate cox regression analysis, and the results are depicted as hazard ratios (HR) with 95% confidence intervals (CI). To determine whether there was an additional benefit of using the SI to determine in-hospital mortality and to interpret the sensitivity and specificity of the SI and its cut-off value for mortality, a receiver operating characteristic (ROC) curve analysis was performed. In addition, the AUC or C-statistic was used as a measure of the predictive accuracy and capacity to discriminate between the AUC ratio and the ROC curve analysis accompanied by the 95% CI. AUC values greater than 0.70 were used as a good indicator of predictive performance, whereas those less than 0.70 were classified as inadequate. Kaplan-Meier survival curves and long-rank tests were used to demonstrate the time to event curves in the graphics. P-values <0.05 have been indicated statistical significance. The Statistical Package for the Social Sciences version 24.0 software (IBM Corp., Armonk, NY, USA) was used for statistical analyses.

RESULTS

The study population included 623 patients with ACS with a mean age of 61.9±12.2 years. Patients with mortality were significantly older (68.9±13.3 vs. 61.2±11.9; p<0.001). Furthermore, mortality was higher in male patients (p=0.006). There were no significant differences between the groups in terms of other cardiovascular risk factors, cardiovascular disease history, and medications (p>0.05 for all). Moreover, patients who developed mortality had lower LVEF (41.4±11.1 vs. 46.0±10.1; p=0.001) and higher Killip class (p=0.022) than those who did not suffer from mortality. In terms of adverse events during hospitalization, acute heart failure (p<0.001), cardiogenic shock (p<0.001, fatal ventricular arrhythmias (p<0.001), high-grade atrioventricular block requiring pacemaker implantation (p<0.001), acute renal failure (p=0.002), and ischemic cerebrovascular accident (p<0.001) were significantly more frequent in patients with mortality. On the other hand, no significant differences were observed between the groups in terms of post-procedural MI and major bleeding (p>0.05 for all).

Additionally, there was no difference between the groups in terms of biochemical markers and hematological parameters (p>0.05 for all). In addition, patients with mortality had significantly lower systolic blood pressure, whereas they had higher heart rate and SI values than those without mortality (p<0.001 for all). The detailed demographic, clinical, and laboratory parameters of all study participants and their comparisons between the two groups are presented in Table 1.

Considering the angiographic and procedural parameters of all study population, patients in the mortality group had more three-vessel disease (p=0.010) and more extensive and severe coronary disease, as determined by the SYNTAX score, compared with the others (p<0.001).

In addition, patients who died during the hospitalization period had more LMCA disease (p=0.008) and needed more

Table 1. Demographic, clinical, and laboratory parameters of survivors and non-survivors

Variables	All populations (n=623)	Survivor (n=564, 90.5%)	Non-survivor (n=59, 9.5%)	p-value
Male gender, n %	488 (73.3)	450 (79.8)	38 (64.4)	0.006
Age, years	61.9±12.2	61.2±11.9	68.9±13.3	<0.001
BMI (kg/m^2)	25.9±2.5	25.9±2.5	26.1±2.4	0.713
Hypertension, n (%)	149 (23.9)	135 (23.9)	14 (23.7)	0.972
Diabetes mellitus, n (%)	103 (16.5)	92 (16.3)	11 (18.6)	0.646
Dyslipidemia, n (%)	299 (48.0)	270 (47.9)	29 (49.2)	0.851
Smoking frequency, n (%)	140 (22.5)	128 (22.7)	12 (20.3)	0.680
Family history, n (%)	224 (36.0)	200 (35.5)	24 (40.7)	0.427
Heart failure, n (%)	48 (7.7)	42 (7.4)	6 (10.2)	0.456
CAD history, n (%)	101 (16.2)	90 (16.0)	11 (18.6)	0.594
MI history, n (%)	67 (10.8)	57 (10.1)	10 (16.9)	0.106
PCI history, n (%)	69 (11.1)	63 (11.2)	6 (10.2)	0.816
CABG history, n (%)	27 (4.3)	25 (4.4)	2 (3.4)	0.708
PAD history, n (%)	9 (1.4)	7 (1.2)	2 (3.4)	0.188
CVA history, n (%)	10 (1.6)	8 (1.4)	2 (3.4)	0.252
Chronic renal failure, n (%)	18 (2.9)	15 (2.7)	3 (5.1)	0.270
COPD, n (%)	8 (1.3)	6 (1.1)	2 (3.4)	0.131
Medications, n (%)				
Acetylsalicylic acid	87 (14.0)	80 (14.2)	7 (11.9)	0.625
P2Y12 receptor blockers	15 (2.4)	14 (2.5)	1 (1.7)	0.707
RAS blockers	81 (13.0)	69 (12.2)	12 (20.3)	0.078
Beta blockers	88 (14.1)	79 (14.0)	9 (15.3)	0.794
Statins	86 (13.8)	76 (13.5)	10 (16.9)	0.462
Antianginals	29 (4.7)	28 (5.0)	1 (1.7)	0.257
OADs	92 (14.8)	83 (14.7)	9 (15.3)	0.912
Insulin	25 (4.0)	22 (3.9)	3 (5.1)	0.659
High KILLIP class, n (%)	48 (7.7)	39 (6.9)	9 (15.3)	0.022
LVEF %	45.6±10.2	46.0±10.1	41.4±11.1	0.001
SBP upon admission, n (%)	126±16.9	127±16	112±23	<0.001
HR upon admission, n (%)	82.2±17.1	81±15	98±28	<0.001
SI upon admission, n (%), IQR	0.64 (0.55-0.74)	0.64 (0.55-0.73)	0.73 (0.64-1.24)	<0.001
Admission diagnosis, n (%)				
STEMI	252 (40.5)	220 (39.1)	32 (54.2)	0.024
NSTEMI	345 (55.5)	320 (56.8)	25 (42.4)	0.033
UAP	25 (4.0)	23 (4.1)	2 (3.4)	0.796
FBG, mg/dL	134.0±56.8	134.0±54.9	133.4±59.8	0.932
Creatinine, mg/dL, IQR	1.03 (0.85-1.10)	1.03 (0.85-1.10)	1.05 (0.90-1.15)	0.427
Total cholesterol level, mg/dL	206.9±48.1	207.1±47.6	205.2±52.5	0.768
LDL-C, mg/dL	128.8±44.2	129.1±44.1	125.0±45.1	0.535
HDL-C, mg/dL	40.9±8.6	41.0±8.3	40.0±10.5	0.453
Triglyceride level, mg/dL, IQR	170.0 (122.0-247.0)	169.0 (122.0-246.5)	170.0 (116.0-247.0)	0.659
Hemoglobin, g/dL	13.7±1.5	13.6±1.6	14.0±1.3	0.060

Table 1. Continued

Variables	All populations (n=623)	Survivor (n=564, 90.5%)	Non-survivor (n=59, 9.5%)	p-value
Admission diagnosis, n (%)				
White blood cell count, 10^9/L	8.6±2.4	8.6±2.4	8.6±2.3	0.972
Platelet, 10^9/L	268.5±68.0	267.4±67.2	278.9±78.9	0.220
FBG, mg/dL	134.0±56.8	134.0±54.9	133.4±59.8	0.932
Postprocedural MI, n (%)	12 (1.9)	10 (1.8)	2 (3.4)	0.390
Postprocedural acute heart failure, n (%)	31 (5.0)	10 (1.8)	21 (35.6)	<0.001
Postprocedural cardiogenic shock, n (%)	18 (2.9)	7 (1.2)	11 (18.6)	<0.001
Postprocedural acute renal failure, n (%)	21 (3.2)	15 (2.7)	6 (10.2)	0.002
Postprocedural ischemic CVA, n (%)	9 (1.4)	5 (0.9)	4 (6.8)	<0.001
Postprocedural major bleeding	18 (2.9)	14 (2.5)	4 (6.8)	0.061
Postprocedural fatal VAs, n (%)	20 (3.2)	8 (1.4)	12 (20.3)	<0.001
Postprocedural new AF, n (%)	7 (1.1)	7 (1.2)	0 (0.0)	0.389
Postprocedural high-grade block, n (%)	13 (2.1)	4 (0.7)	9 (15.3)	<0.001
Hospitalization period	3.0 (2.0-3.0)	2.0 (2.0-3.0)	5.0 (4.0-9.0)	<0.001

AF: Atrial fibrillation, BMI: Body mass index, CABG: Coronary artery bypass graft, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease, CVA: Cerebrovascular accident, FBG: Fasting blood glucose, HDL: High-density lipoprotein, HR: Heart rate, LDL: Low-density lipoprotein, LVEF: Left ventricular ejection fraction, MI: Myocardial Infarction, OAD: Oral antidiabetic, PAD: Peripheral arterial disease, PCI: Percutaneous coronary intervention, RAS: Renin angiotensin receptor, SBP: Systolic blood pressure, SI: Shock index, IQR: Interquartile range

emergency bypass surgery (p<0.001). In the present study, 577 patients (92.6%) underwent PCI for the culprit lesion, and 58 of them had poor thrombolysis in myocardial infarction (TIMI) <3 flow. Patients with poor TIMI flow had a significantly higher mortality (p=0.034). There were no significant differences between the groups in terms of stent thrombosis (p=0.745). The detailed procedural parameters of the participants are summarized in Table 2.

To determine the independent predictors of in-hospital mortality, we performed multivariate cox regression analysis by including variables that exhibited statistically significant relationships in the univariate analysis. The independent predictors of in-hospital mortality were as follows according to the univariate analysis; age, lower LVEF, higher anatomical SYNTAX score, and SI (Table 3).

To test the diagnostic performance of SI in predicting in-hospital mortality, we also performed ROC curve analysis. ROC analysis exhibited that SI had adequate discriminative power for predicting in-hospital mortality (AUC: 0.711, 95% CI: 0.632-0.789, p<0.001) (Figure 1). Furthermore, we observed that an AUC value of 0.69 had a 68 % sensitivity and 65% specificity for the prediction of mortality.

Kaplan-Meier curves indicated that high-risk patients with higher SI values of 0.69 and above had significantly poorer survey than the low-risk group during the follow-up period after index hospitalization (p=0.001) (Figure 2).

DISCUSSION

In this study, we investigated the variables that can independently predict the in-hospital mortality rates of patients with ACS and multivessel disease treated with PCI or surgical revascularization. Age, lower LVEF, SYTANX score, and SI were independent predictors of in-hospital mortality. In studies on SI, the cut-off value associated with adverse cardiovascular outcomes varies, but it is generally established at 0.7. In our study, we found this cut-off value to be 0.69, which is consistent with the results of other studies (15). Our results were concordant with those of previous studies conducted on this patient group (13-15).

Heart rate is an important prognostic indicator in ACS patients. There is a significant relationship between an HR > 80 beats per minute and in-hospital mortality in both STEMI and NSTEMI patients (16). Bangalore et al. (17) noted a J-shaped relationship between heart rate and in-hospital mortality in patients with NSTEMI, indicating that both very slow and very fast heart rates are associated with increased in-hospital mortality. In this study, even in patients with heart rates within normal limits (60-100 bpm), a heart rate of 90-99 bpm is associated with approximately a 50% increase in all-cause mortality (odds ratio: 1.49, 95% CI: 1.32-1.68) (17). Similarly, Bangalore et al. (18) showed that in patients with ACS, there is a J- or U-shaped relationship between blood pressure and adverse cardiovascular events.

Table 2. Angiographic and procedural parameters of survivors and non-survivors

Variables	All populations (n=623)	Survivor (n=564, 90.5%)	Non-survivor (n=59, 9.5%)	p-value
Two vessel disease, n (%)	332 (53.3)	310 (55.0)	22 (37.3)	0.010
Three vessel disease, n (%)	290 (46.5)	253 (44.9)	37 (62.7)	0.009
SYNTAX score 1	20.2±5.3	19.9±5.0	22.8±6.7	<0.001
Culprit lesion, n (%)				
LAD and side branches	242 (38.8)	214 (37.9)	28 (47.5)	0.657
CX and side branches	105 (16.9)	95 (16.8)	10 (16.9)	
RCA and side branches	252 (40.4)	233 (41.3)	19 (32.2)	
By-pass grafts	10 (1.6)	9 (1.6)	1 (1.7)	
Undetermined	14 (2.2)	13 (2.3)	1 (1.7)	
LMCA disease, n (%)	30 (4.8)	23 (4.1)	7 (11.9)	0.008
CTO, n (%)	31 (5.0)	29 (5.2)	2 (3.4)	0.554
Bifurcation, n (%)	110 (19.1)	99 (19.0)	11 (20.8)	0.752
PCI, n (%)	577 (92.6)	524 (92.9)	53 (89.8)	0.390
CABG, n (%)	125 (20.1)	108 (19.1)	17 (28.8)	0.078
Urgent CABG, n (%)	15 (2.6)	6 (1.1)	9 (17.0)	<0.001
PCI stent type, n (%)				
BMS	197 (31.6)	177 (31.4)	20 (33.9)	0.693
DES	426 (68.4)	387 (68.6)	39 (66.1)	
Postprocedural TIMI <3 flow in culprit vessel	58 (9.3)	48 (9.5)	10 (16.9)	0.034
Stent thrombosis, n (%)	8 (1.4)	7 (1.3)	1 (1.9)	0.745

CABG: Coronary artery bypass graft, CTO: Chronic total occlusion, CX: Circumflex artery, LAD: Left anterior descending artery, LMCA: Left main coronary artery, PCI: Percutaneous coronary intervention, RCA: Right coronary artery, TIMI: Thrombolysis in myocardial infarction

Table 3. Factors independently associated with in-hospital mortality in univariate and multivariate Cox regression analyses

Variables	Univariate		Multivariate	
	HR (95% CI)	**p-value**	**HR (95% CI)**	**p-value**
Age	1.053 (1.030-1.077)	<0.001	1.041 (1.013-1.070)	0.004
Male Sex	0.458 (0.259-0.812)	0.007	0.531 (0.258-1.092)	0.085
LVEF	0.959 (0.934-0.984)	0.001	0.942 (0.913-0.972)	<0.001
High Killip class	2.423 (1.110-5.290)	0.026	2.191 (0.843-5.698)	0.108
TIMI <3 flow	0.456 (0.217-0.957)	0.038	0.550 (0.201-1.500)	0.243
SYNTAX score 1	1.108 (1.053-1.167)	<0.001	1.065 (1.015-1.117)	0.006
SI	1.052 (1.037-1.067)	<0.001	1.055 (1.038-1.073)	<0.001

*The variables with a p-value of less than 0.05 in the univariate analysis were incorporated into the multivariate logistic regression analysis using the Enter method. LVEF: Left ventricular ejection fraction, SI: Shock index, TIMI: Thrombolysis in myocardial infarction, CI: Confidence interval, HR: Hazard ratio

The relationship between blood pressure and adverse cardiovascular events is applicable to both systolic and diastolic blood pressure. In this study, blood pressure valuesbelow 110/70 mm Hg were found to be significantly associated with adverse cardiovascular events, including death (18). In accordance with these scientific findings, our study revealed that patients in the in-hospital mortality group had lower mean systolic blood pressure and higher mean heart rate than those in the survival group.

Since SI is a clinical parameter obtained by dividing the heart rate by the systolic blood pressure, an increase in heart rate and/or a decrease in blood pressure mathematically leads to an increase in the SI value. Since both high heart rate and low blood pressure are associated with adverse outcomes in patients with ACS, the finding that elevated SI values were also linked to negative outcomes is consistent with scientific evidence. Hence, our study also identified an SI value of 0.69 or higher as an independent predictor of in-hospital mortality in patients with ACS. In addition to SI, other independent predictors of in-hospital mortality include age, EF, and SYNTAX score. Advanced age, low EF, and high SYNTAX scores were associated with adverse outcomes in patients with acute MI (19-21). In patients with MVD, the significant association between advanced age, low EF, and high SYNTAX scores and in-hospital mortality can be explained by several factors. These factors include increased myocardial damage leading to reduced myocardial systolic function due to

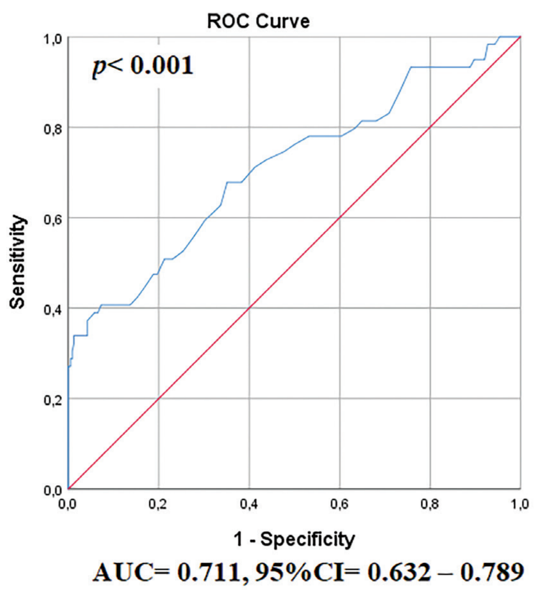

Figure 1. Predictive performance of SI in determining in-hospital mortality

AUC: Area under the curve, CI: Confidence interval, ROC: Receiver operating characteristic curve, SI: Shock index

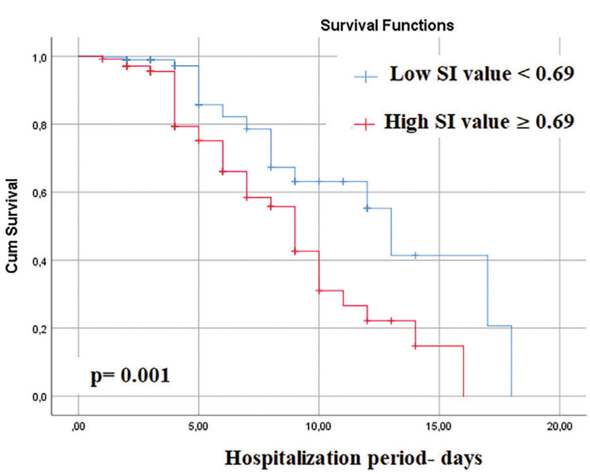

Figure 2. The Kaplan-Meier curve demonstrated that patients with a high SI value (≥0.69) had a poorer prognosis than those with a low SI value (<0.69)

SI: Shock index

more complex coronary artery disease and the frailty of patients due to advanced age.

The SI was first introduced by Allgöwer and Burri (22) in 1967 to assess hemodynamic status and disease severity. Since then, the SI has been used to evaluate various clinical scenarios across different disciplines. The prognostic significance of this strategy has been investigated not only for the severity of cardiovascular disease but also for many patient groups, including emergency medicine, trauma, obstetrics, and pediatrics (23). Only using heart rate and systolic blood pressure to obtain this indicator makes it a valuable parameter, as it can be easily applied to each patient group through simple vital sign monitoring and provides effective predictions about clinical outcomes.

Study Limitations

Although our study has the power to elucidate the prognostic impact of SI, it has several limitations. First, our study has the limitation of being a retrospective study with a small sample size. Second, we calculated the SI only at the first admission; thus, we could not evaluate the temporal changes in the SI and its impact on in-hospital mortality. Finally, we do not have long-term data on the patients' primary endpoints, which can limit the strength of the study.

CONCLUSION

In conclusion, our study found that the SI was a statistically significant predictor of in-hospital mortality in patients with MVD who were treated with PCI or surgical revascularization for ACS. A significant proportion of patients with ACS have MVD, highlighting the need for further studies to validate the clinical importance of SI as an effective, simple, and cost-effective predictor for these patients.

Ethics

Ethics Committee Approval: Study protocol was approved by the University of Health Sciences Turkey, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital Ethics Committee (number: E-28001928-604.01-263765499, date: 27.12.2024).

Informed Consent: Due to retrospective nature of the study informed consent of patients were waived.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.K., Concept: M.K., Design: M.K., Data Collection or Processing: M.K., A.G., Analysis or Interpretation M.K., A.G., Literature Search: M.K., A.G., Writing: M.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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