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Do Mortality Risk Scores Predict The Severity of Coronary Artery Disease In Patients With Myocardial Infarction With St Elevation?

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ABSTRACT

Acute coronary syndromes (ACS), including ST Elevation Myocardial Infarction (STEMI), is the most responsible reason for cardiac deaths. All adverse events, including death, can be reduced with the correct, rapid diagnosis and appropriate treatment options. For this purpose, risk scoring has been developed and used in daily practice. In our study, we aimed to evaluate the place of risk scores used to assess mortality in STEMI patients in predicting coronary artery disease (CAD) severity.

In our study, 293 STEMI patients were enrolled. These patients underwent coronary angiography, and GRACE, TIMI, Zwolle, PAMI, CADILLAC risk scores, and SYNTAX score (SS) were calculated. The specific ability of mortality risk scores was assessed using the area under the curve or the C statistical method.

The number of patients with high SS was 112 (%38.2). Compared to the ROC curves of the risk scores in determining the presence of severe CAD, all of the results were significant, similar, and highly predictive. The 'area under the curve values of severe CAD, TIMI, Zwolle, PAMI, and CADILLAC were found to be 0.658, 0.675, 0.716, 0.679, and 0.703, respectively. ($p<0.001$).

Mortality risk scores were similar, significant, and effective in predicting high SS, the highest rate being the Zwolle score, in patients admitted to our clinic with STEMI. Using these risk scores in a simple and fast way before and after coronary angiography will provide an essential benefit for predicting mortality and predicting the presence and severity of CAD.

Keywords: STEMI, Mortality Risk Score, Syntax Score

Introduction

Coronary artery disease (CAD) is still the leading cause of death despite advances in diagnosis and treatment. The most important group is acute coronary syndrome (ACS) patients. In the national registries of European countries, the in-hospital mortality rate of STEMI patients varies between 4-12%, and the 1-year mortality rate has been reported to be approximately 10% (1).

STEMI is important among ACS because of its high mortality and possible complications. Therefore, clinically correct diagnosis, appropriate treatment selection, and prognosis determination are very substantial. For this reason, risk scoring systems have been developed. Global Registry of Acute Coronary Events (GRACE), The Thrombolysis in Myocardial Infarction (TIMI), Zwolle, Primary Angioplasty in Myocardial Infarction (PAMI), Controlled Abciximab and Device Investigation to Lower Late Angioplasty complications to assess short- and long-term mortality in STEMI (CADILLAC) risk scoring is frequently used in current practice. Syntax Score (SS) is commonly used to evaluate the scope and severity of CAD.

STEMI patients are at high risk of mortality, and risk assessment is very important in determining

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the treatment strategy to be applied to the patient and predicting the prognosis. Predicting SS, which is difficult to calculate and can only be calculated after coronary angiography, by mortality scores which are easily accessible and simply calculated, will provide very useful results in estimating the severity of CAD. We aimed to evaluate the role of GRACE, TIMI, Zwolle, PAMI, and CADILLAC risk scores in predicting the extent and severity of CAD in patients admitted to our clinic with a diagnosis of STEMI and had coronary angiography (CAG).

Material and Methods

A total of 293 patients who underwent CAG with the diagnosis of STEMI between 2017 and 2019 were included in the study. Patients under 18, those who underwent CAG other than STEMI, and those with coronary artery bypass graft operation were excluded from the study. Our study is a single-center retrospective study approved by the local ethics committee and conducted in accordance with the Declaration of Helsinki.

The patients' data were determined by scanning backward from the hospital information system. Clinical anamnesis, physical examination findings, electrocardiography (ECG) findings, echocardiography (ECHO) findings, and laboratory results of the patients were obtained from the patient file and hospital information system. CAG images of the patients were viewed from the computer recording system of the catheter laboratory.

Hypertension (HT) was defined as systolic blood pressure >140 mm Hg and/or diastolic blood pressure >90 mm Hg or antihypertensive drug use. Diabetes mellitus (DM) was defined as fasting blood glucose ≥126 mg/dl or the use of anti-diabetic medication. Patients with a history of CAD were defined as those diagnosed with CAD by invasive or non-invasive imaging methods. Renal failure was defined as a glomerular filtration rate (GFR) below 60 ml/min using the Cockroft-Gault equation. Anemia was defined as Hb value <12 g/dl in women and <13 g/dl in men.

Laboratory examinations of the patients were taken immediately after the patient applied to the hospital, and these findings were obtained from the hospital information system. ECGs were taken within 10 minutes after admission to the hospital, and the ECG result was obtained from the patient's epicrisis and file. STEMI was diagnosed according to the fourth universal definition of Myocardial Infarction (2).

ECO (Vivid 7 GE Vingmed Ultrasound, Horten, Norway) was applied to the patients before or after CAG at the time of admission. This information was obtained from the hospital information system and patient file.

Scores:

TIMI Risk Score; A scoring system used to estimate 30-day mortality using variables such as age, DM, HT, presence of angina, Killip class, heart rate, systolic blood pressure, patient's weight, presence of anterior wall infarction, and left bundle branch block (LBBB) (3-5).

PAMI Risk Score; It is a score used to estimate 30-day, 6-month, and in-hospital mortality using variables such as heart rate, age, DM history, Killip class, presence of anterior wall infarction, and LBBB (6).

GRACE Risk Score; Variables such as heart rate, systolic blood pressure, age, Killip class, serum creatinine value, presence of ST elevation in ECG, the elevation of cardiac biomarkers, and presence of cardiac arrest are used; An improved scoring system to predict in-hospital, 6- and 36-month mortality (7, 8).

Zwolle Risk Score; It is a score used to estimate 30-day mortality using variables such as age, Killip class, flow after TIMI, number of diseased vessels, presence of anterior wall infarction, and ischemia time (9).

CADILLAC risk score; It is a score used to estimate 30-day and 1-year mortality using variables such as age, Killip class, ejection fraction, kidney damage, number of diseased vessels, and presence of anemia (10).

Mortality Risk Scores and their components are shown in Table 1.

SYNTAX score; It is an anatomical scoring system created by considering the number of lesions, the functional significance of the lesion, and its location. In addition, studies have shown that SS also predicts mortality (11, 12).

Mortality Risk Scores and SYNTAX scores of 293 patients were calculated online from a web calculator. Patients with SD <22 were considered non-severe CAD, and patients with ≥23 were considered severe CAD. In-hospital, 30-day, 6-month, and 1-year mortality status of the patients were determined by scanning the hospital information system and death notification system.

Statistical Analysis: When evaluating study data, numerical variables were defined as mean + standard deviation, and categorical variables as percentages or ratios. The prognostic value and discriminating ability of clinical risk scores were evaluated using the area

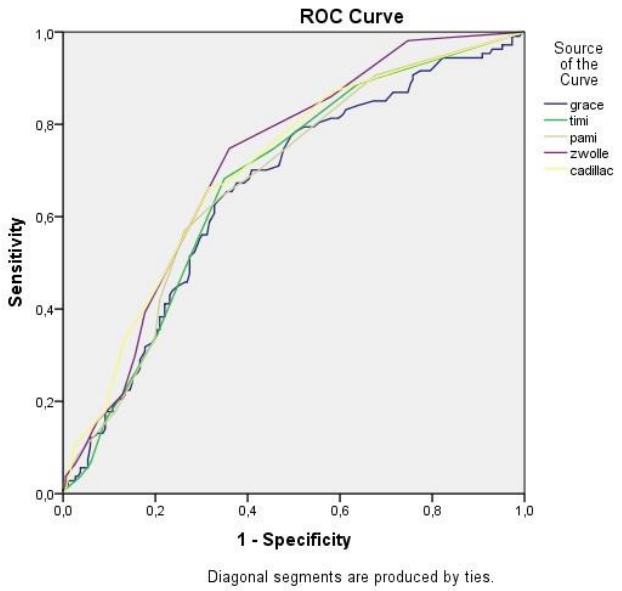

Fig. 1. Roc Curve for Predicting Coronary Artery Disease Severity Evaluated by Syntax Score of Mortality Risk Scores

under the curve or the C statistical method. Logistic regression models were used to calculate the C statistic, and the estimated probability was calculated, and this probability was compared using the ROC (Receiver Operating Characteristic) curve. Thus, the area under the curve (AUC) was obtained. The area under the ROC curve or statistical index C was used to measure each risk score's predictive accuracy. SPSS v21.0 (IBM, Armonk, NY, USA) package program was used for statistical analysis. For statistical significance, $p<0.05$ was accepted.

Ethics Committee Approval: Ethics committee approval of our study was received from the local ethics committee on 04.10.2018, number: 253, meeting number: 06, and decision number: 26.

Results

Our study group consisted of 293 STEMI patients who underwent CAG, consisting of 235 (80.2%) men with a mean age of 61.6 ± 12.6 years. The baseline demographic and laboratory characteristics of the patients are shown in Table 2.

Mortality risk scores (GRACE, TIMI, PAMI, Zwolle, CADILLAC) and SYNTAX score were calculated according to the findings of the patients. 38.2% of the patients had a high SYNTAX score. In-hospital mortality was 6.8%, thirty-day mortality was 9.9%, six-month mortality was 12.6%, and one-year mortality was 14.3%, as shown in Table 3.

The mortality risk scoring results in predicting the severity of CAD were compared and are shown in table 4. According to these results, all mortality risk scores were significant and similarly effective in predicting a high SYNTAX score ($P<0.05$). The correlation between Zwolle risk score and SS was prominent. It was determined that the CADILLAC score predicted the SS with the highest sensitivity and the TIMI score with the highest specificity. Patients with GRACE score ≥118 67.3% sensitivity and 62.4% specificity, TIMI score ≥3.5 patients 68.2% sensitivity and 65.1% specificity, PAMI score ≥2.5 patients 70.1% sensitivity and 57.5% specificity, Zwolle risk score ≥2.5% patients 74.8 sensitivity and 64% specificity, patients with CADILLAC risk score ≥ 3.5 were found to predict high SYNTAX score with 85% sensitivity and 44.1% specificity. The results of the ROC Curve analysis performed according to these results are shown in Figure 1.

Discussion

It was found that all of the mortality risk scores, frequently used in estimating mortality in cardiology practice, predicted a significant and similarly high SS, that is, severe CAD. According to the results of this study, it was seen that the prevalence and severity of CAD could be estimated using all of the mortality scores without the need to calculate the SS. Again, according to the results of our study, GRACE, TIMI, and PAMI scores (before CAG); Zwolle, and CADILLAC scores (after CAG), can provide significant benefits in estimating the severity of CAD, determining the treatment strategy, and predicting prognosis with its early, simple and rapid use.

Günaydın ZY et al. found that Score and Framingham risk scores were applicable to predict the severity of CAD in their study on 227 patients using the risk scoring system used in stable coronary artery disease (13). Our study was conducted in STEMI patients with a higher risk group and worse prognosis. It was observed that all of the mortality scores used were correlated with the SS, which evaluates the severity of CAD.

GRACE and TIMI risk scores are the most frequently calculated risk scores in ACS patients. CADILLAC, Zwolle, and PAMI risk scores are older and are used less frequently today. All of these scores show significant results in predicting mortality. However, studies on its use in estimating the severity of CAD is limited. In the study of Reza Rahmani et al., with 330 patients diagnosed with unstable angina pectoris and non-STEMI, they observed that the GRACE score had a moderate efficiency in predicting the severity of CAD (14). Avcı BK et al., in their study of 207 non-STEMI patients showed that a high GRACE score could predict high-severity CAD (15). Bekler A et al.,

Table 1. Mortality Risk Scores and Components

Variable	TIMI	ZWOLLE	PAMI	CADİLLAC	GRACE
Age	X	X	X	X	X
Diabetes Mellitus	X		X		
Hypertension	X				
Angina Pectoris	X				
Systolic Blood Pressure	X				X
Heart Rate	X		X		X
Killip Classification	X	X	X	X	X
Weight	X				
Anterior Myocardial Infarction or Left bundle branch block	X	X	X		
Ischemia time	X	X			
Cardiac Arrest					X
ST-Segment Elevation					X
Cardiac Enzyme Increase					X
Renal Function				X	X
Post TIMI Flow		X		X	
Three Vessel Disease		X		X	
Ejection Fraction				X	
Anemia				X	

in their study of 287 ACS (154 non-STEMI, 133 STEMI) patients, GRACE score was found to be correlated with SS (16). In a study by Hammami et al., in 238 non-STEMI patients, GRACE and TIMI scores were moderately correlated in predicting the severity of CAD as assessed by SS (17). In the study of Öner E et al., in 145 non-STEMI patients, they observed that a high GRACE score predicted the severity of CAD and that the TIMI score was significantly but weakly correlated with the SS (18). In our study, similar to these studies, GRACE, and TIMI scores were found to be correlated with SS in predicting the severity of CAD. However, our patient population consists of STEMI patients who are at higher risk and need to be diagnosed and treated more quickly.

As in our study, studies were also conducted with laboratory parameters to predict the severity of CAD simply and easily. Zeren G et al. found that cardiac type fatty acid binding protein level did not predict the severity of CAD in their study on 49 non-STEMI patients (19), and Kilit C et al. observed that serum alkaline phosphate level did not predict the severity of CAD in their study performed in 200 patients with ACS (20). In the study of Içen YK et al., in 279 non-STEMI patients, the decrease in basophil level indicates the severity of CAD (21). In another study conducted by Karabulut D et al., in 166 STEMI patients, it was observed that high sensitive troponin and high sensitive CRP levels predicted the severity of CAD (22). Our study shows that these parameters, which are relatively neglected to be calculated in ACS patients but which should be routinely calculated, can be used to predict the severity of CAD quickly and simply.

In literature studies, comparisons of mortality risk scores have been made to predict mortality. However, limited data are available on the effectiveness of these scores in predicting SS, that is, the extent and severity of CAD. As it is known, CAG is necessary for calculating SS. In this context, using mortality scores, which are easier and faster to calculate, may contribute to current practice.

In conclusion, mortality risk scoring in patients who presented with STEMI and underwent CAG significantly and effectively predicted high SS, indicating the common severity of CAD. Using these risk scores before and after CAG by calculating simply and quickly can be useful for predicting mortality as well as predicting the prevalence and severity of CAD. The easy calculation of these scores after the patient's admission will contribute to predicting patients who are expected to have severe CAD, selecting the appropriate treatment protocol for these patients, and predicting prognosis. Therefore, we think these risk scorings, mostly ignored in daily practice, should be used more in

Table 2: Baseline Demographic and Laboratory Characteristics of the Patients

Variable	TOTAL PATIENTS (n = 293)	SYNTAX 0-22 (n = 181)	SYNTAX ≥ 23 (n = 112)
Age (year)	61.6 ± 12.6	59.5 ± 12.4	64.9 ± 12.4
Gender (Male, %)	235 (%80.2)	151 (83.4)	84 (75)
SBP (mmHg)	119.6 ± 18.7	120.7 ± 17.8	118.1 ± 20.2
HR (bpm)	80 ± 18	77.8 ± 17.3	83.5 ± 18.7
HT (number, %)	89 (%30.4)	48 (26.5)	41 (36.6)
DM (number, %)	69 (%23.5)	38 (21)	31 (27.7)
CAD (number, %)	56 (%19.1)	37 (20.4)	19 (17)
CVD (number, %)	29 (%9.9)	14 (7.7)	15 (13.4)
COPD (number, %)	6 (%2)	3 (1.7)	3 (2.7)
AF (number, %)	7 (%2.4)	4 (2.2)	3 (2.7)
Cardiac arrest (number, %)	27 (%9.2)	12 (6.6)	15 (13.4)
Killip Classification (n, %)			
1	230 (%78.5)	154 (85.1)	76 (67.9)
2	51 (%17.4)	24 (13.3)	27 (24.1)
3	3 (%1)	0 (0)	3 (2.7)
4	9 (3.1)	3 (1.7)	6 (5.4)
EF (%)	42.3 ± 8.6	44.1 ± 8.2	39.4 ± 8.4
Post TIMI Flow (number, %)	28 (%9.6)	16 (8.8)	12 (10.7)
0	1 (%0.3)	1 (0.6)	1 (0.9)
1	5 (%1.7)	0 (0)	4 (3.6)
2	259 (%88.4)	164 (90.6)	95 (84.8)
3			
Hb (g/dl)	14.4 ± 2.2	14.5 ± 2.2	14.1 ± 2.3
Glu (mg/dl)	155.1 ± 95.2	145.8 ± 77.9	170.1 ± 116.8
Cre (mg/dl)	1.07 ± 0.82	1.05 ± 0.86	1.10 ± 0.75
TC (mg/dl)	201.3 ± 58.7	203 ± 51.3	198.5 ± 69.1
LDL (mg/dl)	133.9 ± 39.4	136.1 ± 37.3	130.4 ± 42.7
HDL (mg/dl)	42.2 ± 10	42.3 ± 9.2	41.9 ± 11.1
TG (mg/dl)	152.3 ± 125.7	162.9 ± 142.1	135.2 ± 91.5
Troponin (pg/ml)	19.3 ± 22.7	17.2 ± 20.6	22.7 ± 25.6
GRACE	123 ± 35.25	116.14 ± 32.9	134.10 ± 36.14
TIMI	3.77 ± 2.69	3.21 ± 2.60	4.69 ± 2.61
PAMI	3.82 ± 3.34	3.07 ± 3.15	5.04 ± 3.29
ZWOLLE	3.27 ± 3.03	2.51 ± 2.70	4.49 ± 3.14
CADILLAC	5.11 ± 3.90	4.11 ± 3.67	9.72 ± 3.74
SYNTAX	20.1 ± 11.78	12.7 ± 5.71	32.10 ± 8.76

Abbreviations: SBP: Systolic Blood Pressure, HR: Heart Rate, bpm: bpm: beats per min, HT: hypertension, DM: diabetes mellitus, CAD: coronary artery disease, CVD: Cerebrovascular disease, COPD: chronic obstructive pulmonary disease, AF: atrial fibrillation, EF: Ejection Fraction, Hb: hemoglobin, Glu: Glucose, Cre: Creatinine, TC: Total Cholesterol, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, TG: Triglyceride, GRACE: Global Registry for Acute Coronary Events, TIMI: Thrombolysis In Myocardial Infarction, PAMI: Primary Angioplasty in Myocardial Infarction, CADILLAC: Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications;

Table 3: Scoring and Mortality Results

Mortality	N (%)
In-hospital mortality (number, %)	20 (% 6.8)
30-Day mortality (number, %)	29 (% 9.9)
6- Month mortality (number, %)	37 (% 12.6)
1-Year mortality (number, %)	42 (% 14.3)

Table 4: Results of Mortality Risk Scores for Predicting Coronary Artery Disease Severity Evaluated by Syntax Score

Score	AUC	%95 CI	P-Value	Sensitivity	Specificity
GRACE	0,658	0,594-0,722	<0,001	67,3	62,4
TIMI	0,675	0,613-0,737	<0,001	68,2	65,1
PAMI	0,679	0,617-0,741	<0,001	70,1	57,5
ZWOLLE	0,716	0,657-0,775	<0,001	74,8	64
CADILLAC	0,703	0,542-0,764	<0,001	85	44,1

AUC: area under the curve or C statistic; CI: confidence intervals; GRACE: Global Registry for Acute Coronary Events; TIMI: Thrombolysis In Myocardial Infarction; PAMI: Primary Angioplasty in Myocardial Infarction; CADILLAC: Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications;

determining treatment strategies and predicting prognosis.

Limitations: The relatively small number of patients, the fact that it was a single-center study, and the retrospective analysis of patient information through file records are the important limitations of our study. In addition, the fact that the female/male ratio is higher in favor of males shows us that this study should have more data on females. More accurate results can be obtained by conducting large-scale studies involving larger numbers of patients.

Ethics Committee Approval: Ethics committee approval of our study was received from the local ethics committee on 04.10.2018, number: 253, meeting number: 06, and decision number: 26.

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