Dicle Tıp Dergisi / Dicle Med J (2019) 46 (4) : 847 - 855

www.diclemedj.org

Özgün Araştırma / Original Article

Usefulness of the CHA2DS2-VASc Score to Predict "St Segment Resolution Failure" In Patients Treated with Primary Percutaneous Coronary Intervention for St-Segment Elevation Myocardial Infarction

Fatih Aksoy[1], İsmail Barkın Işık[2], Hasan aydin Baş[3], Ali Bağcı[4], Fatih Kahraman[5], Yunus Emre Okudan[6], Mevlüt Serdar Kuyumcu[7], Ahmet Altınbaş[8]

1 Department of Cardiology, Suleyman Demirel University, Medical School, Isparta, Turkey ORCID: 0000-0002-6480-4935
2 Physician, Department of Cardiology, Rize Devlet Hastanesi, Rize, Turkey ORCID: 0000-0002-7193-827X
3 Physician, Department of Cardiology, Isparta City Hospital Isparta, Turkey ORCID: 0000-0001-7110-3443
4 Physician, Department of Cardiology, Isparta City Hospital Isparta, Turkey ORCID: 0000-0002-8792-6329
5 Physician, Department of Cardiology, Kütahya State Hospital Kütahya, Turkey ORCID: 0000-0003-3860-2755
6 Physician, Department of Cardiology, Seka State Hospital Kocaeli, Turkey ORCID: 0000-0003-1330-1884
7 Department of Cardiology, Suleyman Demirel University, Medical School, Isparta, Turkey ORCID: 0000-0003-1330-1884
8 Department of Cardiology, Suleyman Demirel University, Medical School, Isparta, Turkey ORCID: 0000-0002-1813-9305

Received: 27.05.2019; Revised: 12.09.2019; Accepted: 24.09.2019

Abstract

Objective: Rapid supply of coronary blood flow in the occluded coronary artery is the principle aim of early ST-elevation myocardial infarction (STEMI) therapy. Although coronary blood flow has been supplied, insufficient myocardial reperfusion mainly at the level of micro vascular circulation has been assessed a large number of patients. Electrocardiographically by measuring ST-segment resolution (STR) after procedure is an easy and good indicator for the evaluation of reperfusion failure. The CHA2DS2-VASc risk score is used to predict the risk of thromboembolism in non-valvular AF patients. Its usefulness in predicting AF in the development of STR failure in patients presenting with STEMI is unknown. We evaluated the predictive value of the CHA2DS2-VASc score in patients with STR failure following STEMI.

Methods: Models including clinical and laboratory parameters were constructed to test the predictive value of CHA2DS2-VASc and CHA2DS2-VASc -HS scores. Patients were divided into two groups: those with STR> 70 % and those without STR> 70. Predictors of STR failure were determined by multivariate regression analysis.

Results: Multiple regression analysis showed that CHA2DS2-VASc-HS score, Anterior STEMI, peak CK-MB level and symptom to percutaneous coronary intervention time were associated with development of STR failure in patients presenting with STEMI. ROC curve analyses showed that CHA2DS2-VASc and CHA2DS2-VASc -HS scores were significant predictors for STR failure.

Conclusion: CHA2DS2-VASc and CHA2DS2-VASc -HS scores predict STR failure in patients presenting STEMI.

Keywords*:* CHA2DS2-VASc scores, ST segment resolution, myocardial infarction

DOI: 10.5798/dicletip.570650

Yazışma Adresi / Correspondence: *Fatih Aksoy, Cunur Mahallesi, PK: 32200 Suleyman Demirel Univesitesi Tip Fakultesi, Isparta, Turkey*
e-mail: dr.aksoy@hotmail.com

CHADS2-VASc skorunun primer perkutan koroner girişim yapılan ST yükselmeli miyokart enfarktüslü hastalarda ST segment rezolusyonunu öngörmedeki yararlılığı

Öz

Amaç: Tıkalı koroner arterde hızlı koroner kan akımın sağlanması, ST yükselmeli miyokart enfarktüsü (STYMI) tedavisinin temel amacıdır. Her ne kadar koroner kan akımı sağlanmış olsa da, çoğunlukla mikrovasküler düzeyde yetersiz miyokart reperfüzyonu çok sayıda hastada saptanmıştır. Elektrokardiyografik olarak işlem sonrası ST-segment rezolusyonunu (STR) ölçmek reperfüzyon başarısını değerlendirilmek için kolay ve iyi bir göstergedir. CHA2DS2-VASc risk skoru, valvüler olmayan AF hastalarında tromboembolizm riskini tahmin etmek için kullanılır. STEMI ile başvuran hastalarda STR yetersizliğinin gelişmesini öngörmedeki yararı bilinmemektedir. STEMI sonrası STR' nun değerlendirilmesinde CHA2DS2-VASc skorunun ön gördürücü değerinin araştırılması amaçlanmıştır.

Yöntemler: CHA2DS2-VASc ve CHA2DS2-VASc -HS puanlarının ön gördürücü değerini test etmek için klinik ve laboratuvar parametrelerini içeren modeller yapıldı. Hastalar STR>% 70 olan ve olmayan olarak iki gruba ayrıldı. STR başarısızlığının ön gördürücüleri, çok değişkenli regresyon analizi ile belirlendi.

Bulgular: Çalışmada % 70 STR saptanmayan hastalarda CHA2DS2-VASc ve CHA2DS2-VASc-HS skorları anlamlı olarak yüksekti. Çoklu regresyon analizi, CHA2DS2-VASc-HS skoru, anterior STYMI, pik CK-MB seviyesi ve perkütan koroner girişim zamanının STEMI ile başvuran hastalarda yetersiz STR gelişimi ile ilişkili olduğunu gösterdi. ROC eğrisi analizi, CHA2DS2-VASc ve CHA2DS2-VASc –HS skorlarının STR başarısızlığı için ön gördürücü olduğunu göstermiştir.

Sonuç: CHA2DS2-VASc ve CHA2DS2-VASc -HS skorları, STEMI ile başvuran hastalarda başarısız STR öngörmektedir.

Anahtar kelimeler: CHA2DS2-VASc skoru, ST segment rezolusyonu, miyokart enfarktüsü.

INTRODUCTION

Rapid supply of coronary blood flow in the occluded coronary artery is the principle aim of early ST-elevation myocardial infarction (STEMI) therapy. Primary percutaneous coronary intervention (p-PCI) is recommended for acute STEMI patients who present within the first few hours after the onset of symptoms, as the preferred reperfusion strategy[1]. Although coronary blood flow has been supplied, insufficient myocardial reperfusion mainly at the level of micro vascular circulation has been assessed a large number of patients. Failure of reperfusion can be determined angiographically by evaluating thrombolysis in myocardial infarction (TIMI) flow grade, TIMI frame count and myocardial blush score in angiographic evaluation and electrocardiographically by measuring ST-segment resolution (STR) after procedure[2,3]. Furthermore, reperfusion failure is associated with death, MI, and impaired left ventricular function. STR is an easy and good indicator for the evaluation of reperfusion failure. Additionally, even if coronary blood flow is provided, adequate perfusion of myocyte may not be supplied. That is why, STR after p-PCI is important to assess whether appropriate perfusion is achieved in the heart micro vessels, because of several studies which have shown a relationship between different degrees of STR and clinical outcomes[4,5]. The CHA2DS2-VASc risk score is a cheap and easy scoring system that is calculated by assigning a score of 1 point for each of the following conditions: congestive heart failure (ejection fraction< 40%), hypertension, age between 65 and 74 years, diabetes mellitus, vascular disease (myocardial infarction or peripheral arterial disease) and female gender; a score of 2 points for the following conditions: history of stroke or transient ischemic attack (TIA) and age > 75 years. The CHA2DS2-VASc risk score is used to predict the risk of thromboembolism in non-valvular AF patients[6]. Recent study has shown an association between CHA2DS2-VASc risk score and reperfusion failure after

thrombolytic therapy in patients with STEMI[7]. Moreover, we showed that CHA2DS2-VASC score have been predicted AF following STEMI and associated with epicardial fat tissue[8,9].

To our knowledge, there is no study evaluating the relationship between CHA2DS2-VASc risk score and reperfusion failure after p-PCI in patients with STEMI. Therefore, we aimed to investigate reperfusion failure in patients with STEMI using CHA2DS2-VASc risk score.

METHODS

Patients

In this prospective study, 384 consecutive patients with STEMI were screened between January 2014 and December 2015. Inclusion criteria included age greater than 18 years, and presence of STEMI. Exclusion criteria, no-reflow and failed of the p-PCI, hyperthyroidism, history of AF (paroxysmal, persistent, or permanent), moderate to severe heart valve disease, history of congestive heart failure, advanced chronic obstructive pulmonary disease, infection, sepsis, rheumatic or inflammatory disease and history of malignancy. Out of 384 consecutive patients with acute STEMI, five patients with hyperthyroidism, six patients with severe heart valve disease, four patients with advanced chronic obstructive pulmonary disease, two patient with sepsis, three patients with a history of malignancy and ten patients with a history of AF were excluded (Figure 1). Therefore, the final study cohort consisted of 384 patients with STEMI. The institutional ethics committee approved the study and all participants provided written informed consent (Decision No: 13.12.2018-247).

Diagnosis of STEMI

Diagnoses were recorded by the participating physicians based on clinical, electrocardiographic and biochemical (elevated troponin levels) criteria. The type of myocardial infarction (ST-elevation vs. non-ST-elevation) and unstable angina were homogeneously defined based on current guidelines[8,10].

Scores

CHADS score was calculated as follows: 1 point each for congestive heart failure, hypertension, age >75 years, and diabetes mellitus, and 2 points for history of stroke. CHA2DS2-VASc score was calculated with additional variables: 1 point each for age >65 years, history of vascular disease, and female gender and 2 points for age >75 years. CHA2DS2-VASC-HS score was calculated with additional variables: 1 point each for history of smoking, history of hyperlipidemia and male gender, additionally female gender was 0 point.

Electrocardiography

Electrocardiography (ECG) was taken to all patients who enrolled the study, in admission and 60 min after the first balloon inflation. The sum of ST-segment elevation was measured 20 ms after the end of the QRS complex. The ST-segment elevation resolution was calculated as the initial sum of ST-segment elevation minus the sum of ST-segment elevation on the second ECG divided by the initial sum of ST-segment elevation and expressed as a percentage. Patients were divided into two groups according to the ST-segment resolution: < 70% (no resolution); and > 70% (complete resolution)[11]. Analysis of ST-segment elevation resolution was performed in the ECG core laboratory by personnel unaware of reperfusion status or follow-up information.

Angiographic examination and definitions

All patients were treated according to currently available guidelines[12]. Primary percutaneous coronary intervention was performed on all patients. Selective coronary angiography was performed using the Judkins technique. Angiograms were measured by 2 independent, blinded cardiologists. The patients underwent transthoracic echocardiography and the left

ventricular ejection fraction was calculated by Simpson's method[13]. Patients who had Thrombolysis in Myocardial Infarction (TIMI) III flow after p-PCI were accepted as successful p-PCI.

Blood sampling

Blood samples were drawn from the antecubital vein by careful venipuncture using a 21 G sterile syringe without stasis between 08.00–10.00 AM after a fasting period of 12 h. Glucose, creatinine and lipid profiles were determined by standard methods. Hemogram parameters were measured in a blood sample collected in dipotassium EDTA tubes (Vacuette). An automatic blood counter (Beckman-Coulter Co, Miami, FL, USA) was used for whole blood counts.

Statistical Analysis

SPSS version 16.0 and MedCalc version 15.2 software package were used for statistical analyses in this study. Categorical variables were expressed as frequency (%) and compared with the $\chi 2$ test. Kolmogorov-Smirnov test was used to test the distribution of numeric variables; those with normal distribution were expressed as mean ± standard deviation and were compared with Student's t-test. Data without normal distribution were expressed as median and were compared with the Mann-Whitney U test. In all statistical analyses, p value <0.05 was considered as statistically significant. The correlations between CHA2DS2-VASc risk score, STR and other clinical, laboratory and echocardiographic parameters were performed with Pearson or Spearman correlation analysis where appropriate. Univariate analysis of binary logistic regression was carried out to identify which factors were associated with failure of STR. After including each of these potential confounding factors, backward conditional binary logistic regression analysis was performed to estimate the odds ratio (OR) and 95% confidence interval (95% CI) for prediction of STR failure. Receiver operating characteristics (ROC) curve analysis was used to analyze the prognostic value of CHA2DS2-VASc score for STR failure, following STEMI. All ROC comparisons were performed using the DeLong test[14]. C-Statistic (area under the curve) was presented as a unified estimate of sensitivity and specificity, that is the highest value of Youden's J index (sensitivity + specificity −1). According to the cut off value that was obtained by a ROC curve analysis; the study population could be segregated into two groups as low risk and high risk. Binary logistic regression was carried out on these two groups as well.

RESULTS

Demographic and clinical characteristics of the patients with and without STR are listed in Table 1. Compared with patients with STR < 70%, those with complete STR were younger, female, shorter duration of the chest pain and were high likely to have anterior myocardial infarction. Diabetes mellitus, hypertension, hyperlipidemia, obesity, prior myocardial infarction rates were higher in patients with STR < 70% than in patients with ≥ 70%. There was no significant difference between two groups regarding smoking.

There were no significant differences regarding cholesterol levels including low density cholesterol, high density cholesterol, triglycerides. Peak creatinin kinase- myocardial bundle and initial glucose levels were higher in patients with STR < 70% than in patients with ≥ 70 % (for both parameters p< 0.001). Left ventricle ejection fraction was significantly lower (p<0.001) in patients with STR < 70% than in patients with ≥ 70 %.

Table I: Demographic and clinical characteristics of patients with and without STR > 70 %

	ST segment resolution < 70 % (n= 139)	ST segment resolution > 70 % (n= 178)	P- value
CHADS2 Score (median) (IQR)	1.6 ± 0.9 (2.0)	0.5 ± 0.8 (0.0)	< 0.001
CHA2DS2-VASc Score (median)	3.2 ± 1.5 (3.0)	1.1± 1.4 (1.0)	< 0.001
CHA2DS2-VASc-HS Score (median)	4.5 ± 1.3 (5.0)	2.3 ± 1.1 (2.0)	< 0.001
High CHA2DS2-VASc group n, (%)	121 (87)	54(30)	< 0.001
Age (years)	65 ± 11	55 ± 10	< 0.001
Gender (female) n, (%)	67 (48)	53 (29.8)	< 0.001
Diabetes Mellitus n, (%)	58 (41)	24 (14)	< 0.001
Hypertension n, (%)	110 (79)	18 (10)	< 0.001
Hyperlipidemia n, (%)	53 (38)	17 (9.6)	< 0.001
Smoking n, (%)	64 (46)	72 (40)	0.188
Obesity n, (%)	28 (20)	16 (9)	0.004
MI localization (Anterior) n, (%)	76 (54)	51 (28)	< 0.001
History of CAD n, (%)	81 (58)	12 (6.7)	< 0.001
LV ejection fraction (median) (%)	39 ± 11 (45.0)	46 ± 7 (47.5)	< 0.001
Peak CK-MB (mg/dl)	120 ± 22	101 ± 15	< 0.001
Creatinin (mg/dl)	1.0 ± 0.2	0.9 ± 0.1	0.012
LDL- cholesterol (mg/dl)	134 ± 17	127 ± 15	0.361
HDL- cholesterol (mg/dl)	42 ± 4	43 ± 6	0.134
Glucose (mg/dl) (median)	159 ± 92 (93.0)	107 ± 44(92.2)	< 0.001
Symptom to PCI time (median)(hour)	9.0 ± 2.7 (9)	4.8 ± 1.9 (4)	< 0.001

Data presented as mean ± standard deviation, number (%) or median of the patients. Abbreviations: IQR: Inter-quartile range, MI = myocardial infarction; CAD= coronary artery disease; LDL= low-density lipoprotein; HDL = high-density lipoprotein; CK-MB = creatinine kinase-myocardial binding; CHA2DS2-VASc = congestive heart failure, hypertension, age ≥ _75 years, diabetes mellitus, previous stroke, vascular disease, age 65 to 74 years, female gender; CHA2DS2-VASc-HS: congestive heart failure, hypertension, age ≥ _75 years, diabetes mellitus, previous stroke, vascular disease, age 65 to 74 years, male gender, hyperlipidemia and smoking; LV= left ventricle; PCI= Percutaneous coronary intervention.

The mean CHA2DS2-VASc score, CHADS2 score and CHA2DS2-VASc- HS score were significantly higher in patients with STR < 70% than in patients with ≥ 70 % (3.2 ± 1.5, median: 3.0 versus 1.1 ± 1.4, median: 1.0, p< 0.001; 1.6 ± 0.9, median: 2.0 versus 0.5 ± 0.8, median: 0.0, p< 0.001; 4.5 ± 1.3, median: 5.0 versus 2.3 ± 1.1 median: 2.0, p< 0.001).

Predictors of post-PCI complete ST resolution

Univariate analysis showed that high CHA2DS2-VASc, high peak CK-MB level, low left ventricle ejection fraction, long duration of symptom onset-to-balloon time, anterior wall myocardial infarction, high initial glucose level, advanced age, female gender and history of hypertension, diabetes mellitus, hyperlipidemia, obesity were significantly associated with a higher risk of STR failure (Table 2).

Table II: Univariate and multivariate regression analysis of study variables

	Odds ratio	Confidence interval	P-value	Odds ratio	Confidence interval	P-value
CHADS2 Score	3.36	(2.51-4.50)	< 0.001			
CHA2DS2-VASc Score	2.31	(1.93- 2.77)	< 0.001			
CHA2DS2-VASc-HS Score	3.86	(2.919-5.11)	< 0.001	4.54	(2.48-8.27)	< 0.001
High CHA2DS2-VASc group	15	(8.56-27.82)	< 0.001			
Age (years)	1.08	(1.05- 1.10)	< 0.001			
Gender (female)	2.1	(1.38- 3.48)	0.001			
Diabetes Mellitus	4.3	(2.55- 7.57)	< 0.001			
Hypertension	10.1	(5.6- 18.2)	< 0.001			
Hyperlipidemia	5.8	(3.1- 10.6)	< 0.001			
Obesity	2.55	(1.32- 4.94)	0.005			
MI localization (Anterior)	3.00	(1.88- 4.78)	< 0.001	6.56	(2.16-19.9)	0.001
LV ejection fraction	0.90	(0.90- 0.94)	< 0.001			
Glucose	1.011	(1.00- 1.01)	< 0.001			
Peak CKMB	1.05	(1.03- 1.06)	< 0.001	1.042	(1.00-1.075)	0.012
Symptom to PCI time	1.97	(1.71- 2.26)	< 0.001	1.53	(1.30- 1.80)	< 0.001

Abbreviations: MI = myocardial infarction; CK-MB = creatinine kinase-myocardial binding; CHA2DS2-VASc = congestive heart failure, hypertension, age ≥ _75 years, diabetes mellitus, previous stroke, vascular disease, age 65 to 74 years, female gender; CHA2DS2-VASc-HS: congestive heart failure, hypertension, age ≥ _75 years, diabetes mellitus, previous stroke, vascular disease, age 65 to 74 years, male gender, hyperlipidemia and smoking; LV= left ventricle; PCI= Percutaneous coronary intervention.

A multivariate binary logistic regression analysis was carried out by including all characteristics that were associated with STR failure in the univariate analysis. This analysis showed that CHA2DS2-VASc- HS score, peak CK-MB level, long duration of symptom onset-to-balloon time; anterior wall myocardial infarction remained as independent factors for STR failure (Table 2).

Table III: The ROC analysis of risk scores

	C-Statistic (AUC)	Confidence ınterval	P value	Cut off value	Sensitivity (%)	Specificity (%)
CHADS2 Score	0.797	0.793-0.884	<0.001	0.5	87	60
CHA2DS2VASC	0.839	0.747-0.848	<0.001	1.5	87	70
CHA2DS2VASC-HS	0.896	0.861-0.931	<0.001	3.5	80	88

Abbreviations: CHA2DS2-VASc = congestive heart failure, hypertension, age ≥ _75 years, diabetes mellitus, previous stroke, vascular disease, age 65 to 74 years, female gender; CHA2DS2-VASc-HS: congestive heart failure, hypertension, age ≥ _75 years, diabetes mellitus, previous stroke, vascular disease, age 65 to 74 years, male gender, hyperlipidemia and smoking; LV= left ventricle; PCI= Percutaneous coronary intervention.

ROC Analysis

ROC curve analysis showed that CHA2DS2-VASc score (C-statistic: 0.839; 95% CI: 0.747-0.848, p< 0.001), CHADS2 score (C-statistic: 0.797; 95% CI: 0.793-0.884, p< 0.001) and CHA2DS2-VASc-HS score (C-statistic: 0.896; 95% CI: 0.861-0.931, p< 0.001) were significant predictors of STR failure following STEMI after p-PCI (Figure 1). We calculated that a cut-off point of 1.5 for CHA2DS2-VASc score , 0.5 for CHADS2 and 3.5 for CHA2DS2-VASc-HS score could estimate the presence of STR failure with a sensitivity of 87 % ,87 % and 80 % ; a specificity of 70 % ,60 %, 88 % respectively (Figure 2)(Table 3). We carried out a pair-wise comparison of ROC curves. We noted that the predictive value of the tests in predicting STR were different between each other. (by DeLong method14; AUC CHA2DS2-VASc versus AUC CHADS2 z statistic: 3.47 and p= 0.0005, AUC CHA2DS2-VASc versus AUC CHA2DS2-VASc-HS z statistic: 5.30 and p< 0.0001, AUC CHADS2 versus AUC CHA2DS2-VASc-HS z statistic: 6.46 and p< 0.0001).

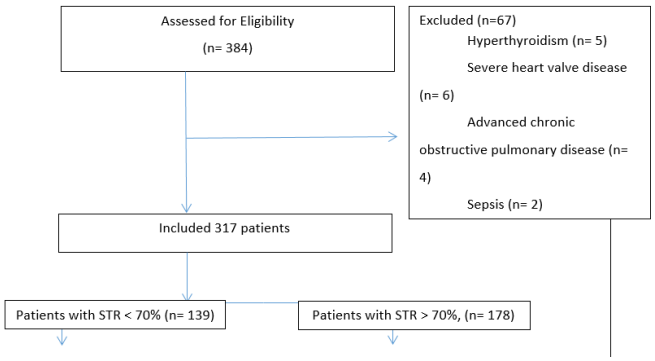

Figure 1. Flow Diagram

DISCUSSION

The present study showed that the CHADS2, CHA2DS2-VASc and CHA2DS2-VASc-HS scores were independently associated with STR and were strong predictors of STR in patients with successfully treatment of STEMI, consequently, both scores could be helpful and appropriate scoring systems for predicting STR following STEMI. Additionally, our study also demonstrated that CHA2DS2-VASc-HS score was superior to CHADS2, CHA2DS2-VASc scores to predict STR. Additionally, CHA2DS2-VASc-HS score >3.5 was found to be an independent predictor of STR failure in patients with STEMI.

Although CHA2DS2-VASC score is recommended for determining thromboembolism risk in patients with nonvalvular atrial fibrillation, it was showed the relationship between this score and various cardiovascular diseases[15-17]. Bozbay et al.[15] demonstrated that CHA2DS2-VASC score was a strong predictor factor of one month in hospital and long term mortality and morbidity. Kilic et al. showed that CHA2DS2-VASC and CHA2DS2-VASC-HS score were independent predictors of failed thrombolysis in patient with STEMI. In our study, CHA2DS2-VASC and CHA2DS2-VASC-HS score were significantly predictors of STR. In patients with STR failure, diabetes

mellitus, hypertension, hyperlipidemia, obesity, anterior wall myocardial infarction were more seen than in patients with successful STR. This association can be explained by inflammation. Diabetes mellitus, hypertension, older age, congestive heart failure and cerebrovascular disease, which are conditions that determine the CHA2DS2-VASc score are also associated with increased inflammatory status in patients[18]. Yilmaz et al.[19] demonstrated a significant positive correlation between CHA2DS2-VASc score and C-reactive protein (CRP) levels. Additionally, Woo et al. showed a significant correlation High sensitive-CRP and STR[20]. Diabetes mellitus has been related to spoiled micro-vascular perfusion after PCI due to the tendency toward endothelial vasoconstriction, micro-vascular dysfunction and thrombosis[21]. Hyperglycemia was related to increased risk of in-hospital mortality in patients with and without DM. Similarly, in present study, initial glucose levels were higher in patients with STR failure than in patients with successful STR. Several mechanisms might explain the effects of hyperglycemia and diabetes mellitus in micro vascular dysfunction. Acute hyperglycemia increases adhesion molecule-1 levels or P- selectin which would increase occlusion of leukocytes in the capillaries[22,23]. Increased occlusion of leukocytes in the capillaries might further conduce to the no-reflow phenomenon and failed of STR[24,25].

The no-reflow phenomenon is defined as a profound reduction in antegrade coronary blood flow (Thrombolysis in Myocardial Infarction [TIMI] flow grade ≤2) despite vessel patency and the absence of dissection, spasm, or distal macroembolus, which is defined as a distal filling defect with an abrupt "cutoff" in one of the peripheral coronary artery branches of the infarct-related vessel, distal to the site of percutaneous coronary intervention. Myocardial no-reflow after p-PCI is associated with worsened clinical events and a bad survival rate after acute ST-segment elevation myocardial infarction (STEMI)[26]. Even if TIMI 3 flow is supplied, microvascular and tissue-level reperfusion is not supplied. Measuring STR after p-PCI is one of the most appropriate methods to assess microvascular damage. Microvascular damage can be due to structural reasons such as myocardium necrosis, or functional reasons such as edema, increased microvasculature constriction, endothelial dysfunction or obstruction with inflammatory cells. Besides the PCI itself can give rise to microvascular obstruction with distal embolization due to thrombus particles or plaque debris[27]. In our study, high CHA2DS2-VASC score was associated with worsened tissue perfusion.

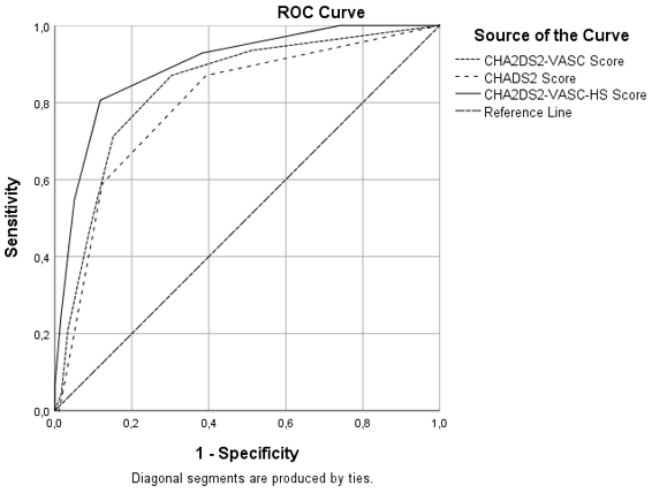

Figure 2. Receiver operating characteristic (ROC) curve with calculated area under the curve and optimal cut-off point for the CHA2DS2VASC score, CHADS2 score and CHA2DS2VASC-HS score to identify the presence of STR failure. C-Statistic (area under the curve) — 95% confidence interval (95% CI): CHADS2: 0.797 (0.793-0.884), P < 0.001; CHA2DS2-VASc: 0.839 (0.747-.0.848), P < 0.001; CHA2DS2VASC-HS: 0.896 (0.861-.0.931), P < 0.001. We calculated that a cut-off point of 1.5 for CHA2DS2-VASc score , 0.5 for CHADS2 and 3.5 for CHA2DS2-VASc-HS score could estimate the presence of STR failure with a sensitivity of 87 % ,87 % and 80 % ; a specificity of 70 % ,60 %, 88 % respectively.

Detecting high-risk patients with STEMI is significant, and several scoring systems have been developed for risk stratification. The TIMI risk score, GRACE risk index, RISK-PCI score,

and CADILLAC risk score are prevalent scoring systems for predicting in-hospital and long-term mortality in STEMI[28-30]. These scoring systems include physical examination, laboratory tests, various demographic, electrocardiographic parameters, angiographic, echocardiographic parameters. Therefore, these scoring systems are confused and not practical for physicians because of plurality and difficulty so the scores like these may not be used easily. However, the CHA2DS2-VASc score is simple and easy scoring system that's why it may be used in predicting STR in patients with STEMI.

Our study determined that the CHA2DS2-VASc is a simple and detailed risk assessment score that ensures an additional level of risk stratification beyond that maintained by traditional risk scores in foreseeing STR in patients undergoing primary PCI with STEMI. This is the first study to evaluate the association among the admission CHADS2 score, CHA2DS2-VASc score, CHA2DS2-VASC-HS score and STR in patients with STEMI who were undergoing primary PCI. The CHA2DS2VASc-HS score is a simple, very useful, easily remembered bedside score for predicting STR in patients with STEMI who were undergoing primary PCI.

Study limitations

This study has several limitations because it was a single-center design and nonrandomized study. We did not calculate CADILLAC risk score; Zwolle primary PCI risk index; TIMI, PAMI, and GRACE risk scores; and SYNTAX score.

CONCLUSION

Our study shows that in patients with STEMI undergoing p-PCI, the CHA2DS2VASc-HS score is a powerful scoring system for detecting STR failure. The CHA2DS2VASc-HS score, which contains a major portion of the long-term prognostic risk factors in the coronary artery disease population, may also be used more generally in patients with STEMI

Declaration of Conflicting Interests: The authors declare that they have no conflict of interest.

Financial Disclosure: No financial support was received.

REFERENCES

1. Neumann F-J, Sousa-Uva M, Ahlsson A, et al. Group ESCSD. 2018 ESC/EACTS Guidelines on myocardial revascularization. European heart journal 2018:ehy394-ehy394.
2. Brener SJ, Dizon JM, Mehran R, et al. Complementary prognostic utility of myocardial blush grade and ST-segment resolution after primary percutaneous coronary intervention: analysis from the HORIZONS-AMI trial. American heart journal 2013; 166: 676-83.
3. Sarkar A, Lee JJ. TIMI Grade Flow StatPearls. Treasure Island (FL), 2018.
4. Somitsu Y, Nakamura M, Degawa T, Yamaguchi T. Prognostic value of slow resolution of ST-segment elevation following successful direct percutaneous transluminal coronary angioplasty for recovery of left ventricular function. The American journal of cardiology 1997; 80: 406-410.
5. Sutton A, Campbell P, Grech E, et al. Failure of thrombolysis: experience with a policy of early angiography and rescue angioplasty for electrocardiographic evidence of failed thrombolysis. Heart 2000; 84: 197-204.
6. Kirchhof P, Benussi S, Kotecha D, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. Eur Heart J 2016; 37: 2893-962.
7. Kilic S, Kocabas U, Can LH, Yavuzgil O, Çetin M, Zoghi M. Predictive value of CHA2DS2-VASc and CHA2DS2-VASc-HS scores for failed reperfusion after thrombolytic therapy in patients with ST-elevation myocardial ınfarction. Cardiology journal 2013.
8. Aksoy F, Bas HA, Bagci A, Oskay T. The CHA2DS2-VASc score for predicting atrial fibrillation in patients presenting with ST elevation myocardial infarction: prospective observational study. Sao Paulo Med J 2019; 137: 248-54.
9. Aksoy F, Guler S, Kahraman F, Oskay T, Varol E. The Relation Between Echocardiographic Epicardial Fat Thickness and CHA2DS2-VASc Score in Patients with Sinus Rhythm. Braz J Cardiovasc Surg 2019; 34: 41-7.

10. Thygesen K, Alpert JS, Jaffe AS, et al. Third universal definition of myocardial infarction. European heart journal 2012; 33: 2551-67.

11. Lee A, Sadick N, Ng A, Hsieh C, Ross D. Prognostic implication of ST-segment resolution following primary percutaneous transluminal coronary angioplasty for ST-elevation acute myocardial infarction. Internal medicine journal 2004; 34: 551-6.

12. Members ATF, Steg PG, James SK, et al. ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force on the management of ST-segment elevation acute myocardial infarction of the European Society of Cardiology (ESC). European heart journal 2012; 33: 2569-19.

13. Folland ED, Parisi AF. Noninvasive evaluation of left ventricular function: the ejection fraction. Compr Ther 1979; 5: 47-54.

14. DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. Biometrics 1988: 837-45.

15. Bozbay M, Uyarel H, Cicek G, et al. CHA2DS2-VASc score predicts in-hospital and long-term clinical outcomes in patients with ST-segment elevation myocardial infarction who were undergoing primary percutaneous coronary intervention. Clinical and Applied Thrombosis/Hemostasis 2017; 23: 132-8.

16. Cetin M, Cakici M, Zencir C, et al. Prediction of coronary artery disease severity using CHADS2 and CHA2DS2-VASc scores and a newly defined CHA2DS2-VASc-HS score. The American journal of cardiology 2014; 113: 950-6.

17. Lip GY, Nieuwlaat R, Pisters R, Lane DA, Crijns HJ. Refining clinical risk stratification for predicting stroke and thromboembolism in atrial fibrillation using a novel risk factor-based approach: the euro heart survey on atrial fibrillation. Chest 2010; 137: 263-72.

18. Tousoulis D, Antoniades C, Stefanadis C. Assessing inflammatory status in cardiovascular disease. Heart 2007; 93: 1001-1007.

19. Yilmaz S, Akboga MK, Aras D, Topaloglu S. Evaluation of the predictive value of CHA2DS2-VASc score for In-Stent Restenosis. Angiology 2018; 69: 38-42.

20. Woo JS, Cho JM, Kim SJ, Kim MK, Kim CJ. Combined assessments of biochemical markers and ST-segment resolution provide additional prognostic information for patients with ST-segment elevation myocardial infarction. Korean circulation journal 2011; 41: 372-8.

21. Iwakura K, Ito H, Ikushima M, et al. Association between hyperglycemia and the no-reflow phenomenon inpatients with acute myocardial infarction. Journal of the American College of Cardiology 2003; 41: 1-7.

22. Marfella R, Esposito K, Giunta R, et al. Circulating adhesion molecules in humans: role of hyperglycemia and hyperinsulinemia. Circulation 2000; 101: 2247-51.

23. Booth G, Stalker TJ, Lefer AM, Scalia R. Elevated ambient glucose induces acute inflammatory events in the microvasculature: effects of insulin. American Journal of Physiology-Endocrinology And Metabolism 2001; 280: E848-E856.

24. Engler RL, Dahlgren MD, Morris DD, Peterson M, Schmid-Schonbein G. Role of leukocytes in response to acute myocardial ischemia and reflow in dogs. American Journal of Physiology-Heart and Circulatory Physiology 1986; 251: H314-H323.

25. Ota S, Tanimoto T, Orii M, et al. Association between hyperglycemia at admission and microvascular obstruction in patients with ST-segment elevation myocardial infarction. Journal of cardiology 2015; 65: 272-7.

26. Ndrepepa G, Tiroch K, Fusaro M, et al. 5-year prognostic value of no-reflow phenomenon after percutaneous coronary intervention in patients with acute myocardial infarction. Journal of the American College of Cardiology 2010; 55: 2383-9.

27. Wu KC, Zerhouni EA, Judd RM, et al. Prognostic significance of microvascular obstruction by magnetic resonance imaging in patients with acute myocardial infarction. Circulation 1998; 97: 765-72.

28. Tang EW, Wong C-K, Herbison P. Global Registry of Acute Coronary Events (GRACE) hospital discharge risk score accurately predicts long-term mortality post acute coronary syndrome. American heart journal 2007; 153: 29-35.

29. Mrdovic I, Savic L, Krljanac G, et al. Predicting 30-day major adverse cardiovascular events after primary percutaneous coronary intervention. The RISK-PCI score. International journal of cardiology 2013; 162: 220-7.

30. Roffi M, Patrono C, Collet JP, et al, Group ESCSD. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). European heart journal 2016; 37: 267-315.