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ORIGINAL ARTICLE

CHA_2DS_2-VASc-HS Score as a Predictor of No-reflow in Patients With ST-segment Elevation Myocardial Infarction Who Underwent Primary Percutaneous Intervention

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Abstract

Background: **Current guidelines for acute ST-segment elevation myocardial infarction (STEMI) patients declared primary percutaneous coronary intervention (PPCI) as the mainstay reperfusion strategy. However, the no-reflow phenomenon (NRP) is a major drawback. The longer ischemia lasts, the more likely NRP is to occur causing more myocardial cell damage.**

Aim: **To correlate the CHA_2DS_2VAScHS score and NPR in patients who presented with STEMI and were treated with PPCI.**

Methods: **Case-control study that included one hundred patients presented with STEMI and treated with PPCI. Patients were further divided into group (A) in which patients developed no-reflow (NR) after PPCI and group (B) in which patients achieved TIMI-III flow after PPCI. CHA_2DS_2VAScHS score was calculated for every patient.**

Results: **The study showed no-reflow increase in patients with higher CHA_2DS_2VAScHS scores and no-reflow in STEMI patients treated with PPCI (*P* value 0.000).**

Conclusion: **CHA_2DS_2VAScHS score is effective in the early prediction of NPR in STEMI patients managed with PPCI.**

Keywords: No-reflow, Percutaneous coronary intervention, ST-segment elevation

1. Introduction

Cardiovascular disease is a leading cause of death. The most critical form of acute coronary syndrome is ST-segment elevation myocardial infarction (STEMI).[1]

Primary percutaneous intervention (PPCI) is currently considered the mainstay treatment strategy for STEMI. Nevertheless, while the infarction-related artery has been opened successfully during PPCI, the myocardium may not have been effectively perfused; this phenomenon is called NRP. Currently, the mechanism of NRP is still obscure, but laboratory and clinical findings propose that it is related to the occlusion of the capillaries, ischemic damage of the endothelium, oxygen-free radicals release, inflammation and other factors.[1]

NRP is linked to more myocardial tissue damage and cardiovascular adverse drawbacks regardless of the size of the infarction. This necessitates another strategy for dealing with NRP.[2] Subsequently, there is a need for a fast, simple and cost-effective method to promote risk stratification of STEMI patients at risk of NRP.

This work aimed to assess the relationship between Congenital Heart Disease Ventricular Atrial Supra heart Score (CHA_2DS_2VAScHS) score and incidence of no-reflow (NR) in STEMI patients treated with PPCI.

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2. Methods

A case-control study was conducted between March 2021 and May 2022 on 100 patients who were admitted to the emergency ward with STEMI and underwent PPCI. They were subdivided into two groups:

(1) Group (A) includes 50 patients who developed NR after PPCI.
(2) Group (B) includes 50 patients who achieved TIMI III flow after PPCI.

2.1. Inclusion criteria

Adult patients with chest pain and ECG changes consistent with STEMI.

2.2. Exclusion criteria

Patients who received thrombolytic therapy, presented after 24 h of symptoms or with renal impairment.

2.3. Ethical considerations

All patients in the research gave informed consent.

2.4. Methods

All patients were subjected to full medical history with focusing on risk factors, clinical examination, ECG, laboratory investigations, echocardiography (if possible), calculation of $CHA_2DS_2VASc.HS$ score (Table 1), coronary angiography, and PPCI.

2.5. Statistical analysis

Statistical presentation and analysis of data were completed via statistical software package (SPSS v.23), using the mean, standard deviation, Chi-square test (χ^2), correlation coefficient, Kruskal Wallis test, post hoc analysis, Kaplan Meier estimation with Log-rank test to assess the relation of CHA2DS2VAScHS score. Receiver Operating Characteristic (ROC) curve was done to assign the cut-off point for $CHA_2DS_2VAScHS$ score as a predictor for NR in STEMI patients treated with PPCI. The *P* value was significant if less than or equal to 0.5.

Table 1. Calculation of $CHA_2DS_2VAScHS$ score.

Nomenclature		Score
C.	Congestive heart failure	1
H.	Hypertension	1
A_2	Age ≥75 years	2
D.	Diabetes Mellitus	1
S_2.	History of stroke or TIA	2
V.	Vascular disease	1
A.	Age 65–74 years	1
Sc.	Sex (male)	1
H.	Hyperlipidemia	1
S.	Smoking	1
Total Maximum	11	

3. Results

Group (A) included 41 (82%) males and nine (18%) females with a ratio of 4.5 : 1 and age between 35 years and 83 years with a mean of 57.94 ± 9.92.37 (74%) Patients were less than 65 years old, 11 (22%) Patients were 65–74 years old and 2 (4%) patients were greater than or equal to 75 years old.

Group(B) included 41 (82%) males and nines (18%) females with a ratio of 4.5 : 1 and age between 29 years and 78 years with a mean 53.92 ± 11.04 (Table 2).

36 (72%) patients of group (A) were hypertensive, 31 (62%) patients were diabetics, 24 (48%) patients were suffering from hyperlipidemia and 37 (74%) patients were smokers (Table 3).

21 (42%) patients of group (A) were suffering from congestive heart failure (CHF) or left ventricular ejection fraction (LVEF) less than 40%, 20 (40%) patients were suffering from vascular diseases with none of the patients presented with stroke (Table 4).

18 (36%) patients of group (B) were hypertensive, 15 (30%) patients were diabetics, 7 (14%) patients were suffering from hyperlipidemia and 30 (60%) patients were smokers (Table 3).

Two (4%) patients were suffering from CHF or LVEF less than 40% and three (6%) patients were suffering from vascular diseases with none of group B presenting with stroke (Table 4).

Although patients with anterior STEMI were the majority in the patients group with NRP constituting 35% of group (A) followed by inferior STEMI (14%) then posterior STEMI (1%) with Lateral STEMI representing the least percentage (0%), the type of STEMI had no statistical significance when compared with the patients of group (B) (Table 5).

$CHA_2DS_2VAScHS$ score in patients group with NR was high and ranged from 2 to 7 (median: 4, IQR: 4–5).

$CHA_2DS_2VAScHS$ score was higher in group (A) than in group (B) and this was a statistically high significant difference with *P* value = 0.000 (Tables 6 and 7).

Using the ROC curve to assign the cut-off point with the best specificity and sensitivity for the diagnosis of NR in STEMI patients, this study revealed that $CHA_2DS_2VAScHS$ score of 3 turned to be the-best-cut off point that could discriminate between STEMI patients complicated by NR. The

Table 2. Descriptive demographic data of the studied groups.

	Group (A) No. = 50	Group (B) No. = 50	Test value	*P*-value	Significance
Sex					
Female	9 (18%)	9 (18%)	0.000*	1.000	NS
Male	41 (82%)	41 (82%)			
Age					
Mean ± SD	57.94 ± 9.92	53.92 ± 11.04	−1.915•	0.058	NS
Range	35–83	29–78			
Age <65	37 (74%)	43 (86%)	2.700*	0.259	NS
Age 65-74	11 (22%)	5 (10%)			
Age ≥75	2 (4%)	2 (4%)			

Table 3. Descriptive data for clinical features of the studied patients (smoking, Hypertension (HTN), diabetes mellitus (DM) and hyperlipidemia).

	Group(A) no (%)	Group(B) no (%)	Test value*	*P* value	Significance
Smoker					
No	13 (26.0%)	20 (40.0%)	2.216	0.137	NS
Yes	37 (74.0%)	30 (60.0%)			
HTN					
No	14 (28.0%)	32 (64.0%)	13.043	0.000	HS
Yes	36 (72.0%)	18 (36.0%)			
Diabetes					
No	19 (38.0%)	35 (70.0%)	10.306	0.001	HS
Yes	31 (62.0%)	15 (30.0%)			
Hyperlipidemia					
No	26 (52.0%)	43 (86.0%)	13.511	0.000	HS
Yes	24 (48.0%)	7 (14.0%)			

Table 4. Descriptive data for clinical features of the studied patients (congestive heart failure (CHF) or left ventricular ejection fraction (LVEF) less than 40%, vascular disease).

	Group (A) No (%)	Group (B) No (%)	Test value*	*P* value	Significance
CHF or LVEF <40%					
No	29 (58.0%)	48 (96.0%)	20.384	0.000	HS
Yes	21 (42.0%)	2 (4.0%)			
Stroke/TIA/Thromboembolism					
No	50 (100.0%)	50 (100.0%)	NA	NA	NA
Yes	0	0			
Vascular Disease					
No	30 (60.0%)	47 (94.0%)	16.318	0.000	HS
Yes	20 (40.0%)	3 (6.0%)			

Table 5. Comparison between group (A) and group (B) regarding the anatomic location of ST segment elevated myocardial infarction.

	Group (A) No. (%)	Group (B) No. (%)	Test value*	*P* value	Significance
STEMI					
Anterior STEMI	35 (70.0%)	31 (62.0%)	1.533	0.675	NS
Inferior STEMI	14 (28.0%)	17 (34.0%)			
Posterior STEMI	1 (2.0%)	1 (2.0%)			
Lateral STEMI	0	1 (2.0%)			

Table 6. Comparison of $CHA_2DS_2VAScHS$ score in group (A) and group (B).

$CHA_2DS_2VAScHS$	Group (A) (n = 50)	Group (B) (n = 50)	Test value[a]	*P*-value	Sig.
Median (IQR)	4 (4–5)	2 (2–3)	−6.955	0.000	HS
Range	2–7	0–4			

[a] Mann Whitney test.

Table 7. Positive correlation between $CHA_2DS_2VAScHS$ score and age.

	CHA_2DS_2-VASc-HS	
	R	*P*-value
Age	0.467	0.001

diagnostic performance was evident by AUC of 0.895 with diagnostic accuracy of 89.5%, the diagnostic sensitivity of 80%, specificity of 86%, positive predictive value (PPV) of 85.1%, and negative predictive value of 81.1% (Table 8 and Fig. 1).

3.1. Assessment of NRP in relation to standard

Logistic regression analysis revealed each of $CHA_2DS_2VAScHS$ score greater than 3, HTN, diabetes, hyperlipidemia, CHF or LVEF less than 40%, and vascular diseases as independent uni-variant risk factors for NRP in STEMI patients treated by PPCI (*P* value: 0.000, 0.000, 0.002, 0.000, 0.000, and 0.000, respectively). The risk factors where *P* less than 0.05 were subjected to multivariable analysis which showed that, for NRP in STEMI patients treated by PPCI, $CHA_2DS_2VAScHS$ score greater than 3, hyperlipidemia, CHF or LVEF less than 40% and vascular diseases are independent risk factors (*P* value: 0.007, 0.014, 0.020, and 0.018, respectively) (Table 9).

4. Discussion

$CHA_2DS_2VAScHS$ score is a novel scoring system which includes CHF (C), HT (H), age greater than or equal to 75 years (A_2), DM (D), history of stroke or transient ischemic attack (S_2), vascular disease (V), age from 65 to 74 years (A), male sex (Sc), hyperlipidemia (H) and smoking (S). This score inserts smoking and hyperlipidemia as other risk factors for CAD, also it uses males instead of females.[3]

Many patients experience NR due to microvascular occlusion. As a part of the CHA_2DS_2VASc scoring system[4]: Diabetes mellitus, hypertension, cardiomyopathy, and female sex were found to be risk factors for coronary microvascular injury. Consequently, most of the risk factors for thromboembolism, and microvascular damage overlap with those causing NRP. The CHA_2DS_2VASc scoring system has high power in predicting thromboembolism and includes most of the risk factors of NPR and thromboembolism at the same time, so it can be used as a risk assessment tool in NRP.[4]

Various researchers have suggested that the CHA_2DS_2VASc score is an independent predictor of NRP and a contemporary meta-analysis confirmed that smoking and male sex are also related to NRP.[5] Consequently, we tried to evaluate the capability of the novel $CHA_2DS_2VAScHS$ score as an independent predictor for NRP.

Previous research has assigned many factors predicting NRP. For example, Zhang et al.[5] mentioned that lower LVEF, length of stent greater than or equal to 20 mm, thrombus burden, Killip class greater than or equal to 3, advanced age, and longer pain-to-balloon time are different independent predictors of NRP. Also, hypertension, anterior STEMIs, smoking history and hyperlipidemia were related to NRP.[5] In our study, we found that vascular disease, smoking, hyperlipidemia, age greater than 65, and male sex are associated with NRP.

The Aim of our study was to analyze the clinical data of patients with acute STEMI undergoing PPCI. This information was then used to screen clinical risk factors related to the NRP to elucidate the capability of the $CHA_2DS_2VAScHS$ score as a novel predictor of NR in STEMI patients treated with PPCI and to establish the reliability and authenticity of this risk score. This score may help decrease the

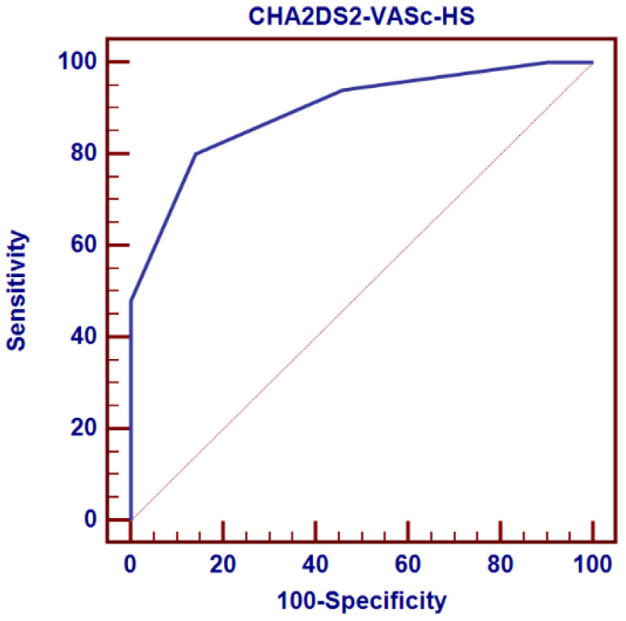

Fig. 1. Receiver Operating Characteristic curve of $CHA_2DS_2VAScHS$ as a predictor of no-reflow phenomenon.

Table 8. Evaluation of $CHA_2DS_2VAScHS$ as a diagnostic tool of no-reflow phenomenon in ST segment elevated myocardial infarction patients.

Parameter	AUC.	Cut of point	Sensitivity	Specificity	PPV.	NPV.
$CHA_2DS_2VAScHS$	0.895	>3	80.0	86.0	85.1	81.1

Table 9. Risk factors in ST segment elevated myocardial infarction patients treated with primary percutaneous intervention with no-reflow phenomenon.

	Uni-variant				Multi-variant			
	P-value	Odds ratio (OR)	95% C.I. for OR		*P*-value	(OR)	95% C.I. for OR	
			Lower	Upper			Lower	Upper
HTN	0.000	4.571	1.963	10.646	0.185	2.758	0.616	12.344
Diabetes	0.002	3.807	1.657	8.747	0.952	1.047	0.230	4.779
Hyperlipidemia	0.000	5.670	2.144	14.997	0.014	5.335	1.404	20.274
CHF or LVEF <40%	0.000	17.379	3.794	79.612	0.020	9.604	1.432	64.414
Vascular Disease	0.000	10.444	2.855	38.211	0.018	7.565	1.423	40.214
$CHA_2DS_2VAScHS$ >3	0.000	24.571	8.534	70.745	0.007	6.900	1.699	28.016

NRP, prevent reperfusion injury, and improve the patient's prognosis.

In our study, the $CHA_2DS_2VAScHS$ scoring system in patients with NRP was high and ranged from 2 to 7. It was higher in patients with NRP than others and this statistical difference was highly significant. This is in accordance with Ipek et al.[4] who showed that the CHA_2DS_2VASc score was higher in NRP patients compared with others.

Using ROC plot graph to assign the best-cut-off with the best specificity and sensitivity for the diagnosis of NRP in STEMI patients. This study revealed that: the $CHA_2DS_2VAScHS$ score of 3 turned out to be the best-cut-off that could discriminate between STEMI patients complicated by NR and TIMI-III flow groups. The diagnostic performance was evident by AUC. of 0.895 with a diagnostic accuracy of 89.5%, specificity of 86%, diagnostic sensitivity of 80% and PPV of 85.1%, and NPV of 81.1%. These findings elucidate the $CHA_2DS_2VAScHS$ score as an independent predictor of NRP. This goes with Ipek et al.[4] who found that the CHA_2DS_2VASc score is correlated to a higher risk of NRP in patients who have undergone PPCI.[4]

Logistic regression analysis revealed each of $CHA_2DS_2VAScHS$ score greater than 3, diabetes mellitus, HTN, hyperlipidemia, CHF or LVEF less than 40%, and vascular diseases as independent uni-variate risk factors for NRP in STEMI patients treated by PPCI. Also, multivariate analysis revealed that for NRP in STEMI patients treated by PPCI, $CHA_2DS_2VAScHS$ score greater than 3, CHF or LVEF less than 40%, hyperlipidemia and vascular diseases are independent risk factors. This is in-accordance with Tartan et al.[6] who suggested that the presence of metabolic syndrome plays an important role in the development of NRP in STEMI treated with PPCI.[6] This also goes with Hu et al.[7] who supported that low LVEF on admission, advanced age, multi-vessel disease, and high blood glucose were risk factors for NRP.[7]

NRP which may occur in STEMI patients treated by PPCI affects the treatment efficiency of PCI. Related risk factors were obtained from our study, and the $CHA_2DS_2VAScHS$ score was quantified to assess each acute STEMI patient before performing PCI according to the score, thus selecting the proper time to conduct treatments in time.

4.1. Conclusion

The $CHA_2DS_2VAScHS$ scoring system is efficient in the early identification of NR during PPCI in STEMI patients. The components of the score were convenient for rapid and early assessment of high-risk categories; which is important for the deciding the suitable intervention.

Authors' contributions

MA collected the samples of the patients in addition to their demographic, clinical, and laboratory data and wrote the manuscript. SR, AM and RA analyzed and interpreted the manuscript. All authors have read and approved the manuscript.

Authors' contributions: The corresponding author collected patients' samples and their clinical, laboratory, and demographic data and formulated the manuscript. All authors analyzed and interpreted the manuscript, also they have read and approved the manuscript.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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Ethics approval and consent to participate

The approval of the study was taken from the Institutional Ethics Committee of the Faculty of

Medicine, Al-Azhar University. Written informed consent was taken from all patients who were invited to participate in the research.

Consent for publication

Not applicable.

Availability of data and materials

The data within this paper and other findings of this study are available from the corresponding author upon reasonable request.

Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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