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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

CHA_2DS_2-VASc score predicts contrast-induced nephropathy in patients with ST-segment elevation myocardial infarction, who have undergone primary percutaneous coronary intervention

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Abstract

Background and aim: We aimed to investigate the predictive value of the CHA_2DS_2-VASc score in the development of contrast-induced nephropathy (CIN).

Methods: A total of 2972 patients who had been diagnosed with ST elevation myocardial infarction (STEMI) and who had undergone primary coronary angioplasty were included in the study. The patients were divided into three groups according to the CHA_2DS_2-VASc score, i.e.: low risk (1 point), intermediate risk (2 points), and high risk (≥ 3 points). The groups were followed with regard to CIN development.

Results: The median CHA_2DS_2-VASc score was significantly higher in the CIN(+) group compared to the CIN(–) group (3 vs. 2, $p < 0.001$). The rate of CIN was 3.32-fold higher (OR 3.32, 95% CI 1.98–5.55, $p < 0.001$) in the high-risk group (CHA_2DS_2-VASc ≥ 3) compared to the low-risk group (CHA_2DS_2-VASc = 1). Age (OR 1.25, 95% CI 1.14–1.36, $p < 0.001$), female gender (OR 1.52, 95% CI 1.23–1.89, $p < 0.001$), hypertension (OR 1.50, 95% CI 1.265–1.78, $p < 0.001$), peak creatinine kinase-MB (OR 1.15, 95% CI 1.10–1.21, $p < 0.001$), and the Killip score > 1 (OR 4.25, 95% CI 3.10–5.82, $p < 0.001$) were found to be independent predictors for CIN development.

Conclusions: The CHA_2DS_2-VASc score is an independent and strong predictor of CIN development in patients with acute STEMI.

Key words: CHA_2DS_2-VASc score, contrast-induced nephropathy, acute ST-segment myocardial infarction, percutaneous coronary intervention

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INTRODUCTION

The CHA_2DS_2-VASc (congestive heart failure or left ventricular systolic dysfunction, hypertension, age ≥ 75 years, diabetes mellitus, previous stroke, vascular disease, age between 65 and 74 years, female gender) score was designed to determine the thromboembolic risk and oral anticoagulant therapy in non-valvular atrial fibrillation [1]. However, it was recognised to also be usefulin the prediction of the severity of coronary artery disease [2] and coronary artery disease-related mortality due to the presence of some common risk factors [3]. It may also be used for prediction of mortality and morbidity in congestive heart failure patients who are candidates for cardiac re-synchronisation treatment [4] and thrombotic events developing after percutaneous coronary intervention (PCI) [5]. It was revealed to be a predictor for thromboembolism, even in patients who do not have atrial fibrillation or who have supra-ventricular arrhythmia [6]. Can a scoring system that has such a large area of use be useful for prediction of contrast-induced nephropathy (CIN)? We tried to address this issue because CIN is an important cause of anxiety for physi-

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cians and a significant cause of iatrogenic acute renal failure [7]. CIN developing after coronary angiography representsone of the important causes of mortality and morbidity [8]. Therefore, a scoring system that predicts CIN development can help us to take measures to prevent renal failure.

METHODS

Patient population

A total of 2972 patients (2473 male, 499 female) who had been admitted to our hospital due to ST elevation acute myocardial infarction (STEMI) and undergone primary PCI (angioplasty and/or stent implantation) were divided to three groups according to the CHA_2DS_2-VASc score as: low risk (CHA_2DS_2-VASc = 1, n = 154), intermediate risk (CHA_2DS_2-VASc = 2, n = 1068), and high risk (CHA_2DS_2-VASc ≥ 3, n = 1750). The groups were followed with regard to CIN.

Analysis of patient data

The clinical and demographic characteristics of the patients, history of diabetes mellitus (DM), arterial hypertension, hyperlipidaemia, stroke or transient ischaemic attack (TIA), coronary artery disease, heart failure, smoking, and family history were recorded. The CHA_2DS_2-VASc score was calculated by giving one point for congestive heart failure (CHF), hypertension, DM, age between 65 and 74 years, female gender, and presence of a vascular disease; and two points for age ≥ 75 years, history of stroke, or TIA. A 12-lead electrocardiogram (ECG) recording was obtained for all patients just after admission, and the type of myocardial infarction (MI) was determined.

Blood samples were obtained at the time of admission and during the follow-up (Coulter LH 780, Beckman Coulter Ireland Inc., Mervue, Galway, Ireland). Echocardiography examination was performed at the left lateral position using a 2.5-MHz phased-array transducer by an experienced cardiologist at the coronary intensive care unit just after the primary PCI (Vingmed GE, Horten, Norway), and the left ventricular ejection fraction (LVEF) was calculated using the modified Simpson formula.

Coronary angiography, primary angioplasty, and stenting

All PCI were performed via the femoral route by an experienced interventional radiologist (Siemens Axiom Artis zee Angiography System, Germany). Non-ionic low-osmolality contrast medium (Omnipaque 350 MG/ml; GE Healthcare, Cork, Ireland) was used for the procedures. All patients were given 300 mg aspirin, 600 mg clopidogrel, or 180 mg ticagrelor loading dose prior to the procedure. 100 U/kg heparin was administered after having visualised the arterial anatomy. Glycoprotein IIb/IIIa use was left to the discretion of the physician. Infarction-related artery was evaluated according to the Thrombolysis In Myocardial Infarction (TIMI) classification. A total of 75 (2.5%) patients in shock underwent additional PCI.

In-hospital follow-up

All patients were transferred to the intensive care unit after the procedure, and treatment continued with 100 mg aspirin, 75 mg clopidogrel, or 90 mg ticagrelor b.i.d. The decision for concurrent use of statins, angiotensin converting enzyme inhibitors, and beta-blockers was made according to the recommendations of the American College of Cardiology/American Heart Association. Use of nephrotoxic agents and non-steroidal anti-inflammatory drugs was avoided. Patients who did not have CHF were administered 1 mL/kg/h of 0.9% isotonic saline solution for 24 h. Oral fluid intake was started 90 min after the procedure for the patients with good general status. Blood pressure and ECG monitoring were performed at the intensive care unit, and control blood samples were obtained. In all patients plasma creatinine were determined values for 72 h after the procedure.

Definitions

Heart failure was defined as moderate or severe left ventricular systolic dysfunction (LVEF < 40%). Arterial hypertension was defined as receiving anti-hypertensive treatment or a systolic blood pressure of ≥ 140 mm Hg or a diastolic blood pressure of ≥ 90 mm Hg. DM was defined as receiving anti-diabetic agent or insulin, or a fasting plasma glucose of ≥ 126 mg/dL. Vascular disease was defined as the presence of a previous MI, complex aortic valve, revascularisation, peripheral artery disease (PAD)-related amputation, or the presence of angiographic evidence of PAD. CIN was defined as 25% or higher elevation in the basal creatinine value or 0.5 mg/dL or higher elevation in the creatinine concentration.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for Windows 20 (IBM SPSS Inc., Chicago, IL) and Medcalc 11.4.2 (MedCalc Software, Mariakerke, Belgium) software. The normality distribution was evaluated using the Kolmogorov-Smirnov test. The normally distributed numerical variables were shown as mean ± standard deviation, and those not normally distributed were shown as median (min–max). The categorical variables were shown as numbers and percentages. In the inter-group comparisons, student's t-test was used for the parametrically distributed data and the Mann-Whitney U test was used for the non-parametrically distributed data. The ANOVA test was used for the parametric data and the Kruskal-Wallis H test was used for the non-parametric data in the comparison of numerical variables between the groups. The χ^2 test, Fisher's exact test, and the Monte Carlo simulation test were used for comparison of the categorical variables. The univariable logistic regression analysis was used to determine the effect

of potential prognostic factors on the presence of CIN, and the independent predictors were determined by inclusion of significant risk factors in the logistic regression model. A p-value of < 0.05 was accepted as statistically significant with 95% confidence interval and 5% alpha error.

RESULTS

Baseline characteristics and laboratory findings

The study population comprised a total of 2972 patients (693 CIN+ and 2279 CIN–). The age range was 26–97 years, and the mean age was 57.2 ± 11.8 years. The proportion of females was 16.8%. The mean age, rate of female gender, DM, hypertension, PCI, MI, anterior MI, shock, Killip > 1, blood pressure < 100 mm Hg, and heart rate > 100/min were significantly higher in the CIN(+) group compared to the CIN(–) group ($p < 0.05$). The LFEF was lower in the CIN(+) group (44.9 ± 10.4 vs. 48.4 ± 7.5%, $p < 0.001$). The median CHA_2DS_2-VASc score was significantly higher in the CIN(+) group (3 vs. 2, $p < 0.001$). The proportion of high-risk patients according to CHA_2DS_2-VASc score was significantly higher in the CIN(+) group (73.7% vs. 54.4%, $p < 0.001$). The demographic data and the other laboratory findings are presented in detail in Table 1. The mean age (high risk: 62 ± 11.6 vs. intermediate risk: 50.5 ± 7.9 vs. low risk: 49.1 ± 7.4 years, $p < 0.001$), the proportions of females (high risk: 28.1% vs. intermediate risk: 0.7% vs. low risk: 0%, $p < 0.001$), DM (high risk: 38.2% vs. intermediate risk: 1.0%, low risk: 0%, $p < 0.001$), and arterial hypertension (high risk: 62.5% vs. intermediate risk: 3.3%, low risk: 0%, $p < 0.001$) were higher in the high-risk group. The other laboratory findings are displayed in Table 2.

Angiographic and procedural characteristics

The proportion of the patients who had two or three stenotic vessels was significantly higher in the CIN(+) group ($p < 0.05$). The percentage of patients with three stenotic vessels was greater in the high-risk group according to the CHA_2DS_2-VASc score (high risk: 29% vs. intermediate risk: 19.2%, low risk: 12.3%, $p < 0.001$). The percentage of the patients with post-procedural TIMI grade < 3 was larger in the high-risk group compared to the other groups (high risk: 18.6% vs. intermediate risk: 8.2%, low risk: 1.3%, $p < 0.001$). The angiographic and procedural characteristics are presented in Tables 3 and 4.

Among the demographic and laboratory findings (Table 1), and the angiographic and procedural characteristics (Table 3), those that were found to be associated with CIN were evaluated as potential risk factors, and they were evaluated with stepwise multivariable logistic regression analysis. The following risk factors for CIN were determined: age (OR 1.25, $p < 0.001$), female gender (OR 1.52, $p < 0.001$), arterial hypertension (OR 1.50, $p < 0.001$), Killip > 1 (OR 4.25, $p < 0.001$), and CHA_2DS_2-VASc score (high risk: OR 3.32, $p < 0.001$). According to the CHA_2DS_2-VASc score, the patients in the high-risk group had a 3.32-fold greater risk for CIN development. The independent predictors for CIN risk are presented in Table 5.

DISCUSSION

We determined that the CHA_2DS_2-VASc score is a strong and independent risk factor for CIN in patients with acute MI. The study indicated that the risk of CIN significantly increases in STEMI, CHA_2DS_2-VASc score ≥ 3, and in who have undergone primary PCI. The present study is the most comprehensive and preliminary study addressing this issue.

The mechanism of CIN remains unclear today, and it is a real challenge for physicians. The CIN incidence varies depending on the study population. While the incidence of CIN related to contrast medium use in the outpatient setting is < 5%, it is higher in patients who undergo coronary angiography (10–15%) [9]. The higher incidence in this group may be associated with the high-risk profile of these patients [10]. This rate was determined as 23.3% in our study. We believe that this high rate may be associated with the fact that our study population comprised high-risk patients with severe co-morbidities. The intra-arterial iodinated contrast use was shown to be more risky than the intra-venous use [11]. In our opinion the use of intra-arterial contrast medium is one of the causes of high CIN rate in patients undergoing coronary intervention. The CIN incidence has decreased in recent years due to the use of less nephrotoxic contrast medium and better prevention strategies [12]. We hope that CIN development may be predicted and its incidence may be decreased if appropriate measures are taken. Our study has shown that CIN, which is one of the important causes of mortality, is still common among hospitalised patients. In addition, contrast medium exposure may lead to long-term outcomes such as death and dialysis-requiring renal failure [13].

The main risk factors for CIN development include impaired renal function, CHF, advanced age (> 65 yeas), DM, nephrotoxic and non-steroidal anti-inflammatory drugs [14], decreased intra-vascular volume and severe dehydration [15], long standing hypotension, sepsis [16], multiple myeloma [17], high-dose contrast medium, and multi-injection use within 72 h [18]. Contrast-medium osmolality is also important. Use of low-osmolality contrast medium instead of high-osmolality contrast medium has been shown to be better for prevention of CIN [19]. Therefore, we preferred to use low-osmolality contrast medium in our study. Furthermore, anaemia, renal transplantation, and female gender [20] were the other risk factors. Consistent with these risk factors, while the mean LVEF was low, the mean age, the rates of DM, hypertension, anaemia, and the proportion of females were higher in the CIN(+) group in our study. As seen here, many important risk factors for CIN are common parameters with the variables of the CHA_2DS_2-VASc score.

Table 1. Baseline characteristics and laboratory findings in patients with and without contrast-induced nephropathy

Variables	All population (n = 2972)	CIN(+) (n = 693)	CIN(–) (n = 2279)	p
Baseline characteristics				
Age [years]:	57.2 ± 11.8	61.2 ± 12.8	56.0 ± 11.1	< 0.001
< 65	2161 (72.7%)	386 (55.7%)	1775 (77.9%)	< 0.001
65–75	543 (18.3%)	182 (26.3%)	361 (15.8%)	< 0.001
≥ 75	268 (9.0%)	125 (18.0%)	143 (6.3%)	< 0.001
Gender (female)	499 (16.8%)	150 (21.6%)	349 (15.3%)	< 0.001
Diabetes mellitus	679 (22.8%)	236 (34.1%)	443 (19.4%)	< 0.001
Hypertension	1128 (38.0%)	315 (45.5%)	813 (35.7%)	< 0.001
Stroke history	80 (2.6%)	11 (1.5%)	69 (3%)	0.476
Family history	565 (19.0%)	120 (17.3%)	445 (19.5%)	0.194
Hyperlipidaemia	962 (32.4%)	209 (30.2%)	753 (33.0%)	0.156
Current smoker	1807 (60.8%)	407 (58.7%)	1400 (61.4%)	0.202
LVEF [%]	47.8 ± 8.4	44.9 ± 10.4	48.4 ± 7.5	< 0.001
Previous CABG	91 (3.1%)	19 (2.7%)	72 (3.2%)	0.576
PCI history	262 (8.8%)	85 (12.3%)	177 (7.8%)	< 0.001
Prior MI	323 (10.9%)	94 (13.6%)	229 (10.0%)	0.009
Anterior MI	1374 (46.2%)	362 (52.2%)	1012 (44.4%)	< 0.001
Shock	121 (4.1%)	86 (12.4%)	35 (1.5%)	< 0.001
Killip class > 1	208 (7.0%)	131 (18.9%)	77 (3.4%)	< 0.001
Blood pressure < 100 mm Hg	294 (9.9%)	134 (19.3%)	160 (7.0%)	< 0.001
Heart rate > 100 bpm	162 (5.5%)	98 (14.1%)	64 (2.8%)	< 0.001
Laboratory findings				
Admission anaemia	726 (24.4%)	221 (31.9%)	505 (22.2%)	< 0.001
First day creatinine [mg/dL]	1.1 (0.6–8.1)	1.3 (0.6–8.1)	1.0 (0.6–5.5)	< 0.001
Peak CK-MB [U/L]	156 (7–1827)	196 (14–1544)	146 (7–1827)	< 0.001
Total cholesterol [mg/dL]	189.3 ± 39.2	190.8 ± 39.0	184.4 ± 39.8	< 0.001
LDL-C [mg/dL]	118.1 ± 30.4	119.2 ± 30.2	114.3 ± 30.9	< 0.001
HDL-C [mg/dL]	40.7 ± 8.7	40.5 ± 8.2	41.5 ± 9.9	0.013
Triglyceride [mg/dL]	132 (20–1649)	132 (20–1649)	126 (26–1150)	0.002
Glucose [mg/dL]	133 (60–614)	144 (61–614)	130 (60–598)	< 0.001
eGFR [mL/min/1.73 m^2]	87.9 (5.4–618)	87.3 (5.4–618)	87.9 (6–349)	0.096
White blood cells [×10^3/μL]	11.6 ± 3.2	12.4 ± 4.2	11.4 ± 2.7	< 0.001
Haemoglobin [g/dL]	13.7 ± 1.8	13.2 ±1.9	13.7 ± 1.7	< 0.001
CHA_2DS_2-VASc score	2 (0–9)	3 (0–9)	2 (0–9)	< 0.001
Low risk (1 point)	154 (5.2%)	17 (2.5%)	137 (6.0%)	< 0.001
Moderate risk (2 point)	1068 (35.9%)	165 (23.8%)	903 (39.6%)	< 0.001
High risk (≥ 3 points)	1750 (58.9%)	511 (73.7%)	1239 (54.4%)	< 0.001

Continuous variables are shown as mean ± standard deviation or median (interquartile range). Categorical variables are reported as numbers (%); CABG — coronary artery bypass grafting; CIN — contrast-induced nephropathy; CK-MB — creatine kinase myocardial band; eGFR — estimated glomerular filtration rate; HDL-C — high-density lipoprotein cholesterol; LDL-C — low-density lipoprotein cholesterol; LVEF — left ventricular ejection fraction; MI — myocardial infarction; PCI — percutaneous coronary intervention

This condition suggests that the CHA_2DS_2-VASc score may be useful for prediction of CIN. Chou et al. [21] demonstrated that a similar scoring system, $CHADS_2$ score, is a simple and useful predictor in stable patients undergoing elective PCI. Although this study is useful, the scoring system and the patients' having stable coronary artery disease are the

Table 2. Baseline characteristics and laboratory findings according to CHA_2DS_2-VASc score

Variables	CHA_2DS_2-VASc score			p
	Low (n = 154)	Moderate (n = 1068)	High (n = 1750)	
Demographic characteristics				
Age [years]:	49.1 ± 7.4	50.5 ± 7.9	62 ± 11.6†	< 0.001
< 65	154 (100.0%)	1052 (98.5%)	955 (54.6%)	< 0.001
65–75	–	16 (1.5%)	527 (30.1%)	< 0.001
≥ 75	–	0 (0.0%)	268 (15.3%)	< 0.001
Gender (female)	–	8 (0.7%)	491 (28.1%)	< 0.001
Diabetes mellitus	–	11 (1.0%)	668 (38.2%)	< 0.001
Hypertension	–	35 (3.3%)	1093 (62.5%)	< 0.001
Family history	25 (16.2%)	202 (18.9%)	338 (19.3%)	0.643
Hyperlipidaemia	56 (36.4%)	345 (32.3%)	561 (32.1%)	0.548
Current smoker	113 (73.4%)	783 (73.3%)	911 (52.1%)	< 0.001
LVEF [%]	61.3 ± 2.6†	48.5 ± 6.4	45.7 ± 8.6	< 0.001
Previous CABG	–	16 (1.5%)	75 (4.3%)	< 0.001
PCI history	–	35 (3.3%)	227 (13.0%)	< 0.001
Prior MI	–	4 (0.4%)	319 (18.2%)	< 0.001
Anterior MI	69 (44.8%)	477 (44.7%)	828 (47.3%)	0.366
Shock	–	14 (1.3%)	107 (6.1%)	< 0.001
Killip class > 1	–	25 (2.3%)	183 (10.5%)	< 0.001
Blood pressure < 100 mm Hg	7 (4.5%)	69 (6.5%)	218 (12.5%)	< 0.001
Heart rate > 100 bpm	2 (1.3%)	21 (2.0%)	139 (7.9%)	< 0.001
CIN:				
Negative	137 (89.0%)	903 (84.6%)	1239 (70.8%)	< 0.001
Positive	17 (11.0%)	165 (15.4%)	511 (29.2%)	< 0.001
Laboratory findings				
Admission anaemia	19 (12.3%)	150 (14.0%)	557 (31.8%)	< 0.001
First day creatinine [mg/dL]	1.0 ± 0.2	1.1 ± 0.3	1.3 ± 0.8†	< 0.001
Peak CK-MB [U/L]	86 (18–446)†	162 (12–1544)	158 (7–1827)	< 0.001
Total cholesterol [mg/dL]	200.1 ± 37.1	193.2 ± 38.5	186.0 ± 39.5†	< 0.001
LDL-C [mg/dL]	128.8 ± 30.8	122.1 ± 30.8	114.7 ± 29.7†	< 0.001
HDL-C [mg/dL]	39.5 ± 8.1	40.1 ± 7.8	41.2 ± 9.2†	< 0.001
Triglyceride [mg/dL]	134 (26–571)	132 (25–1150)	128 (20–1649)†	< 0.001
Glucose [mg/dL]	124.9 ± 37.3	129 ± 38.6	175.3 ± 86.2†	< 0.001
eGFR [mL/min/1.73 m^2]	99.9 ± 22.1	97.9 ± 23.3	82.6 ± 31.8†	< 0.001
White blood cells [$\times 10^3/\mu L$]	11.4 ± 2.3	11.7 ± 2.5	11.6 ± 3.6	0.600
Haemoglobin [g/dL]	14.1 ± 1.2	14.2 ± 1.6	13.2 ± 1.8†	< 0.001

†Differs from other groups ($p < 0.05$). Continuous variables are shown as mean ± standard deviation or median (interquartile range). Categorical variables are reported as numbers (%); CABG — coronary artery bypass grafting; CIN — contrast-induced nephropathy; CK-MB — creatine kinase myocardial band; eGFR — estimated glomerular filtration rate; HDL-C — high-density lipoprotein cholesterol; LDL-C — low-density lipoprotein cholesterol; LVEF — left ventricular ejection fraction; MI — myocardial infarction; PCI — percutaneous coronary intervention

differences in the study. Kurtul et al. [22] noted that the CHA_2DS_2-VASc score had a predictive value for CIN in patients with acute coronary syndrome. Our study is different from that due to the inclusion of only STEMI patients, and the larger number of patients.

Current European Society of Cardiology myocardial revascularisation guidelines recommend risk assessment for acute renal damage for prevention of CIN [23]. This indicates the importance of risk detection for CIN. The CHA_2DS_2-VASc score may be helpful because it can be calculated quickly,

Table 3. Angiographic and procedural characteristics of the patients with and without contrast-induced nephropathy

Variables	All population (n = 2972)	CIN(+) (n = 693)	CIN(–) (n = 2279)	p
Culprit lesion:				0.006
LMCA	7 (0.2%)	3 (0.4%)	4 (0.2%)	
LAD	384 (46.6%)	362 (52.2%)	1022 (44.8%)	
CX	409 (13.8%)	86 (12.4%)	323 (14.2%)	
RCA	1149 (38.7%)	236 (34.1%)	913 (40.1%)	
SVG	19 (0.6%)	6 (0.9%)	13 (0.6%)	
Other	4 (0.1%)	–	4 (0.2%)	
Number of diseased vessels:				0.014
1	1288 (43.3%)	268 (38.7%)	1020 (44.8%)	
2	953 (32.1%)	234 (33.8%)	719 (31.5%)	
3	731 (24.6%)	191 (27.6%)	540 (23.7%)	
Postprocedural TIMI grade < 3	314 (13.9%)	170 (24.5%)	244 (10.7%)	< 0.001
Contrast medium volume [mL]	250 (100–850)	250 (100–750)	250 (100–850)	0.105
Glycoprotein IIb/IIIa receptor inhibitor use	1382 (46.5%)	328 (47.3%)	1054 (46.2%)	0.617
Procedural:	2392 (80.5%)	528 (76.2%)	1864 (81.8%)	0.001
PTCA	27 (1.1%)	4 (0.8%)	23 (1.2%)	0.145
Stent	2328 (97.3%)	520 (98.5%)	1808 (96.9%)	
Both of them	38 (1.6%)	4 (0.8%)	34 (1.8%)	
Antiplatelet treatment:				0.829
Clopidogrel	2942 (99.0%)	687 (99.1%)	2255 (98.9%)	
Ticagrelol	30 (1.0%)	6 (0.9%)	24 (1.1%)	

Mean values (standard deviation) and % (n) are reported for continuous and categorical variables; CIN — contrast-induced nephropathy; CX — circumflex artery; LAD — left anterior descending artery; LMCA — left main coronary artery; PTCA — percutaneous transluminal coronary angioplasty; RCA — right coronary artery; SVG — saphenous vein graft; TIMI — Thrombolysis In Myocardial Infarction

Table 4. Angiographic and procedural characteristics of patients according to CHA_2DS_2-VASc score

Variables	CHA_2DS_2-VASc score			p
	Low (n = 154)	Middle (n = 1068)	High (n = 1750)	
Culprit lesion:				0.594
LMCA	–	2 (0.2%)	5 (0.3%)	
LAD	71 (46.1%)	479 (44.9%)	834 (47.7%)	
CX	19 (12.3%)	163 (15.3%)	227 (13.0%)	
RCA	64 (41.6%)	418 (39.1%)	667 (38.1%)	
SVG	–	4 (0.4%)	15 (0.9%)	
Other	–	2 (0.2%)	2 (0.1%)	
Number of diseased vessels:				< 0.001
1	85 (55.2%)	545 (51.0%)	658 (37.6%)	
2	50 (32.5%)	318 (29.8%)	585 (33.4%)	
3	19 (12.3%)	205 (19.2%)	507 (29.0%)	
Postprocedural TIMI grade < 3	2 (1.3%)	88 (8.2%)	322 (18.6%)	< 0.001
Contrast medium volume [mL]	250 (150–450)	250 (100–850)	250 (100–750)	0.175
Glycoprotein IIb/IIIa receptor inhibitor use	75 (48.7%)	499 (46.7%)	808 (46.2%)	0.820
Stenting:	144 (93.5%)	898 (84.1%)	1350 (77.1%)	< 0.001
PTCA	140 (97.2%)	870 (96.8%)	1318 (97.6%)	
Stent	2 (1.4%)	12 (1.3%)	13 (1.0%)	0.744
Both of them	2 (1.4%)	17 (1.9%)	19 (1.4%)	
Antiplatelet treatment:				0.468
Clopidogrel	152 (98.7%)	1060 (99.3%)	1730 (98.9%)	
Ticagrelor	2 (1.3%)	8 (0.7%)	20 (1.1%)	

Mean values (standard deviation) and % (n) are reported for continuous and categorical variables; CIN — contrast-induced nephropathy; CX — circumflex artery; LAD — left anterior descending artery; LMCA — left main coronary artery; PTCA — percutaneous transluminal coronary angioplasty; RCA — right coronary artery; SVG — saphenous vein graft; TIMI — Thrombolysis In Myocardial Infarction

Table 5. Independent predictors of contrast-induced nephropathy

Variables	OR (95% CI)	p
Age [years]	1.25 (1.14–1.36)	< 0.001
Gender (female)	1.52 (1.23–1.89)	< 0.001
Hypertension	1.50 (1.265–1.78)	< 0.001
Peak CK-MB [U/L]	1.15 (1.10–1.21)	< 0.001
Killip class > 1	4.25 (3.10–5.82)	< 0.001
CHA_2DS_2-VASc score (ref: low):		
Moderate	1.47 (0.86–2.50)	0.153
High	3.32 (1.98–5.55)	< 0.001
Nagelkerke $R^2 = 0.659$; $p < 0.001$		

CI — confidence interval; CK-MB — creatine kinase myocardial band; OR — odds ratio

easily, and remembered easily. It also has importance because it provides valuable data. We found the CIN development risk to be 3.32-fold greater in high-risk patients compared to low-risk patients according to the CHA_2DS_2-VASc score. This observation indicates that physicians should be much more careful with regard to CIN development in high-risk patients, and preventive measures should be initiated early.

We determined that the Killip score of > 1 and the peak creatinine kinase-MB level, which are not included in the CHA_2DS_2-VASc score, are independent predictors for CIN. We suggest that these factors should also be considered for prediction of CIN before angiography. Perhaps a novel scoring system combining these parameters and the CHA_2DS_2-VASc score may be more useful for prediction of CIN. In a study conducted with STEMI patients, the SYNTAX score was also useful for prediction of CIN [24]. However, SYNTAX is an angiographic scoring system. The CHA_2DS_2-VASc score is a system that may be estimated before angiography and enables us to take measures earlier.

In our study, while there was no significant difference between the groups with regard to glomerular filtration rate, we determined that the creatinine level on admission was higher in the CIN group. The creatinine level on admission was shown to be a risk factor for CIN by Ivanes et al. [25]. We did not assess differences between the CIN(+) and CIN(–) groups with regard to smoking, and we did not observe a significant effect of smoking on CIN development.

The rate of patients with three stenotic vessels was higher in the high-risk group according to the CHA_2DS_2-VASc score. The proportion of patients with post-procedural TIMI grade < 3 was higher in the high-risk group compared to the other groups. The CHA_2DS_2-VASc score was shown to indicate the severity of coronary artery disease in previous studies [3]. Our results support these previous studies. In addition, no significant difference was observed between the CIN(+) and CIN(–) groups, and low, intermediate, high-risk groups according to the CHA_2DS_2-VASc score with regard to contrast medium volume.

Limitations of the study

The present study has some limitations, such as being a single-centre study, including only STEMI patients elevation and not completely analysing the potential nephrotoxic drug such as antibiotics and chemotherapeutics.

CONCLUSIONS

We observed that the CHA_2DS_2-VASc score was an independent and strong predictor for CIN development in patients with acute STEMI. Use of the CHA_2DS_2-VASc scoring system may be helpful in taking measures for prevention of CIN development in patients who are to undergo PCI.

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