Original Article

Association between CHA2DS2-VASc score and Contrast-Induced Nephropathy in Patients with Chronic Coronary Syndromes after Percutaneous Coronary Intervention

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Abstract

Introduction: Contrast-induced nephropathy (CIN) causes the third most hospital-related acute renal damage. Thus, early CIN risk detection and prediction are essential to patient care. CHA2DS2-VASc, a simple risk assessment tool, can complement the more advanced CIN risk score model. The objective of this study was to find out the association between CHA2DS2-VASc score and CIN after percutaneous coronary intervention (PCI) in patients with chronic coronary syndromes (CCS).

Methods: This cross-sectional observational study was conducted at the Department of Cardiology at National Institute of Cardiovascular Diseases (NICVD), Dhaka during the period from May, 2020 to April, 2021. A total 100 patients with CCS undergoing PCI were enrolled in this study. CHA2DS2- VASc score was calculated for each patient. These patients were divided into two groups as Group I (score < 4) and Group II (score ≥ 4). After PCI was done, patients were followed up to see development of CIN. CIN was defined as increase in serum creatinine level (≥ 0.5mg/dl) or relative increase (≥ 25%) increase from baseline within 24 to 48 hours after PCI.

Results: The mean CHA2DS2-VASc score was 3.23 ± 1.14. Most of the subjects (41 out of 100) belonged to 51-60 years' age group. Males were prevalent than females. No significant difference was noted regarding history of dyslipidemia, smoking, family history of coronary artery disease between group I and group II except for diabetes mellitus (DM), hypertension and lower left ventricular ejection fraction (LVEF). DM and hypertension were more frequent in group II than group I (28 % vs 56%, p=0.005) and (40 % vs 54%, p= 0.04) respectively. LVEF was lower in group II than group I (54.621% vs 48.06%, p = 0.001). Both pre and post catheterization serum creatinine were significantly higher in group II compared to group I. CIN was significantly higher in group II than group I (24% vs 8%; p=0.029). In multivariate analysis demonstrated CHA2DS2- VASc score of ≥4 to be an independent predictor of CIN.

Conclusion: In patients with CCS undergoing PCI, CHA2DS2-VASc score may be used as a novel, simple, and a sensitive diagnostic tool for the prediction of CIN.

Key words: CIN, CHA2DS2-VASc score, PCI, CCS.

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Introduction

Among all procedures utilizing contrast media (CM) for diagnostic or therapeutic purposes, coronary angiography and percutaneous coronary interventions (PCI) are associated with the highest rates of contrast-induced nephropathy (CIN) [1]. The definition of CIN includes three necessary components: an absolute or relative increase in serum creatinine compared to the baseline [2], a temporal relationship between the rise in serum creatinine and exposure to a contrast agent, and the exclusion of alternative explanations for renal impairment [3]. The most common definition of CIN today is an increase of 25% or more, or an absolute increase of 0.5 mg/dl or more in serum creatinine from baseline value, within 48 h following the exposure to CM. Pre-existing renal disease is defined as a past history of renal artery stenosis, renal failure, glomerulonephritis, renal obstruction, nephrotic syndrome or nephrectomy [4].

CHA2DS2-VASc is a composite scoring system comprising congestive heart failure/left ventricular dysfunction, hypertension, age ≥75 years, diabetes mellitus, previous

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stroke, vascular disease, age 65 to 74 years, and sex (female). It has been traditionally used as a prediction tool for risk of stroke in patients with atrial fibrillation (AF) [5]. Studies have shown the CHA2DS2-VASc score to have a favorable predictive value for adverse clinical outcomes in patients with coronary artery disease (CAD) such as chronic coronary syndrome (CCS) and acute coronary syndrome (ACS) with or without AF [6]. In patients with CCS as well as ACS who undergo PCI, CIN is a known complication and is often associated with an increase in hospital and long-term morbidity, including chronic renal dysfunction and mortality [7]. The incidence of CIN ranges from 7% to 25% in different population subgroups based on the risk status [8]. Hence, risk stratification has an important bearing to provide the appropriate preventive therapies to these high-risk individuals even before CM exposure [9].

In the past, several risk prediction models have been proposed to anticipate CIN incidence. Mehran et al. proposed a scoring system comprising eight variables, which correlated well with the CIN risk [10]. In 2013, Grum et al. [11] introduced another model consisting of 15 parameters, which had a better predictive value for CIN. Despite having a fair degree of accuracy, complexity was one of the major limitations of these models. The components of the CHA2DS2-VASc score viz. age, diabetes and heart failure, have been suggested as risk factors for CIN; hence, this simple scoring system can be used to predict the risk of CIN.

This rating system was applied in a recent research of CCS undergoing elective PCI, and it shown a strong correlation with the occurrence of CIN [12]. This study aimed to assess the predictive validity of the CHA2DS2-VASc Score as a simplified measure for predicting CIN in patients with CCS undergoing PCI.

Methods

This cross-sectional observational study was carried out in the Department of Cardiology at the National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh, over a period of one year from May 2020 to April 2021. The study included 100 patients with CCS who underwent PCI at NICVD during this period. Patients with CCS were eligible if they had chronic stable angina, a history of acute coronary syndrome with stable anginal symptoms, or asymptomatic CAD. Patients were excluded if they had a previous PCI or coronary artery bypass grafting (CABG), known chronic kidney disease, cardiomyopathy, prior use of nephrotoxic drugs before the procedure, or recent exposure to radiographic contrast media within the past 10 days.

Informed written consent was taken from each patient before enrollment. Particulars of the patient and relevant history were taken, and a detailed clinical examination was performed and recorded in a predesigned structured questionnaire. Demographic data such as age, sex, and occupation were recorded. A risk factor profile, including smoking, hypertension, diabetes mellitus (DM), dyslipidemia and a family history of coronary artery disease, was noted.

A 12-lead resting ECG was done at admission and as needed. Aspirin, clopidogrel, beta blockers, statins, and angiotensin-converting enzyme inhibitor/angiotensin receptor blocker medications were administered to every patient unless contraindicated. Laboratory investigations were done on every patient who had CCS under aseptic technique in peripheral veins; blood was then directly put in an automated hematology analyzer for serum creatinine, cardiac troponin I (performed by Access2 of Beckman Coulter), fasting lipid profile, and fasting blood sugar.

The CHA2DS2-VASc score was calculated where the presence of congestive heart failure is 1 point, hypertension 1 point, age >75 years 2 points, diabetes mellitus 1 point, previous stroke or TIA 2 points, vascular disease 1 point, age 65-74 years 1 point, and male gender 1 point. The total score is 10 points. These patients were divided into two groups according to CHA2DS2-VASc score: Group I CHA2DS2-VASc score <4 (low risk) and Group II CHA2DS2-VASc score ≥4 (high risk).

Transthoracic echocardiography was done before coronary angiogram, and left ventricular ejection fraction (LVEF) was measured by modified Simpson's method using a Philips echocardiography machine. Non-ionic, low-osmolar contrast medium was used during the PCI. Post-procedural serum creatinine was measured within 24 to 48 hours after PCI. Data was processed using SPSS 20.0. Quantitative data were expressed as mean with standard deviation, and comparison was done by the Student t-test. Qualitative data were expressed as frequency with percentage, and comparisons were carried out by the chi-square (χ^2) test. Logistic regression analysis with the backward method was performed for a multivariate analysis of independent predictors. A probability value (p) of <0.05 was considered significant.

Results

During this study period, 100 consecutive patients were included in this study. The study samples were divided into two groups based on the CHA2DS2-VASc score. In group I (CHA2DS2-VASc score <4) and group II (CHA2DS2-VASc score ≥4). The mean CHA2DS2-VASc score was 3.23 ± 1.14. Mean age of the patient (Table 1) in group I and group II were 54.32 ±6.74 years and 64.38 ±6.09 years respectively (p=0.001). Males were predominant in both the two group; 74.0% in group I and 82.0% in group II (p=0.503).

Table 1: Demographic profile of the study the study subjects in groups (n=100)

	Group-I	Group-II	p-value
Age (years)			
≤ 40	1 (2.0)	0 (0.0)	
41-50	13 (26.0)	2 (4.0)	
51-60	29 (58.0)	12 (24.0)	
61-70	7 (14.0)	33 (66.0)	
>70	0 (0.0)	3 (6.0)	
Mean ± SD	54.32 ±6.74	64.38±6.09	0.001
Gender			
Male	37 (74.0)	41 (82.0)	0.503
Female	13 (26.0)	9 (18.0)	

SD: standard deviation.

Hypertension was noted statistically lower in group I (40.0%) than group II (54%). Among the group I, 28% had DM and in group II (56%)(p=0.005). Dyslipidemia was present in 38% of group I as opposed to 56% in group II (p=0.071). Smoking history was present 70% and 64% individuals in group I and group II respectively(p=0.523). In both groups, 54% patients had family history of CAD (Table 2).

Table 2: Comparison of the study subjects according to risk factors (n=100)

Cardiac risk factor profiles	Group-I	Group-II	p-value
Hypertension	20 (40.0)	27 (54.0)	0.040
Diabetes mellitus	14 (28.0)	28 (56.0)	0.005
Dyslipidemia	19 (38.0)	28 (56.0)	0.071
Smoking	35 (70.0)	32 (64.0)	0.523
Family history of CAD	27 (54.0)	27 (54.0)	1.000

CAD: coronary artery disease.

On comparing random blood sugar (RBS) level (Table 3), group II patients had significantly higher value than group I (9.17 ± 2.36 vs 8.24 ± 2.27 mmol/l). Both pre and post catheterization serum creatinine were significantly higher in group II compared to group I. The total cholesterol (TC) was significantly higher in Group II (183.34 ± 39.55 mg/dl) compared to Group I (155.8 ± 38.96 mg/dl), with a p-value of 0.010. Similarly, the mean low density lipoprotein (LDL) level was significantly higher in Group II (104.78 ± 27.80 mg/dl) than in Group I (85.00 ± 26.15 mg/dl; p = 0.001). Triglycerides (TG) levels were also significantly elevated in Group II (144.48 ± 31.84 mg/dl) compared to Group I (128.56 ± 34.01 mg/dl; p= 0.018). In contrast, the mean high density lipoprotein (HDL) level showed no significant difference between the two groups (41.68 ± 5.07 mg/dl in Group I and 40.76 ± 6.32 mg/dl in Group II; p = 0.424). LVEF was significantly higher in group I (54.62±7.81%) than in group II (48.06 ±5.84%).

Table 3: Comparison of laboratory and echocardiographic parameters among studied subjects (n=100)

	Group-I (Mean ±SD)	Group-II (Mean ±SD)	p-value
RBS (mmol/l)	8.24 ± 2.27	9.17 ± 2.36	0.047
S. Creatinine (mg/dl) pre-cath	1.14± 0.15	1.23 ± 0.15	0.004
S. Creatinine (mg/dl) post-cath (within 24 -48 hours)	1.15 ±0.16	1.26 ± 0.16	0.002
TC (mg/dl)	155.8± 38.96	183.34± 39.55	0.010
LDL (mg/dl)	85.00 ±26.15	104.78 ±27.80	0.001
TG (mg/dl)	128.56±34.01	144.48 ±31.84	0.018
HDL (mg/dl)	41.68 ± 5.07	40.76 ± 6.32	0.424
LVEF%	54.62±7.81	48.06±5.84	0.0001

SSD: standard deviation; RBS: random blood sugar; TC: total cholesterol; LDL: low density lipoprotein; TG: triglycerides; HDL: high density lipoprotein; LVEF: left ventricular ejection fraction.

CIN developed significantly higher (Table 4) in group II (24.0%) than group I (8.0%).

Table 4: Comparison of CIN in studied subjects (n=100)

CIN	Group I	Group II	p-value
Yes	4 (8.0%)	12 (24.0%)	0.029
No	46(92.0%)	38 (76.0%)	

CIN: contrast induced nephropathy.

DM, hypertension, lower LVEF and higher CHA2DS2-VASc score were found independent risk factor for development of CIN (Table 5). DM has odds ratio 11.05 (p=0.004) and hypertension has odds ratio 4.206 (p=0.45) for CIN. Left ventricular ejection fraction has odds ratio 0.861 (p=0.016). CHA2DS2-VASc score has odds ratio 3.81 (p=0.03).

Table 5: Multivariate logistic regression analysis of risk factors of CIN

Risk factors	β	SE	OR	p-value
LVEF	0.149	0.062	0.861	0.016
Gender	0.888	1.214	0.412	0.465
Hypertension	1.436	0.779	4.206	0.045
Smoking	0.789	0.964	0.454	0.413
DM	2.403	0.830	11.05	0.004
Dyslipidemia	0.829	0.706	2.290	0.240
Age (>65years)	0.564	0.720	1.758	0.433
CHA2DS2-VASc (≥4)	1.33	0.618	3.81	0.030

CIN: contrast induced nephropathy; SE: standard error; OR: odds ratio; LVEF: left ventricular ejection fraction; DM: diabetes mellitus.

Discussion

The important findings of this study were: i) CIN developed significantly higher in patients with higher CHA2DS2-VASc score; ii) DM, hypertension, lower LVEF and higher CHA2DS2-VASc score were found independent risk factor for development of CIN.

The age distribution of the study showed that in group I, the majority (n=29, 58%) were 51-60 years of age, whereas in group II, 66% of people belonged to the higher age group (61-70 years). Age is an integral part of this score, so older people were likely to belong to a higher score group. Age ≥ 75 years scores 2, and 65–74 years scores 1 in the CHA2DS2-VASc scoring system [5]. Moreover, age is an independent predictor of CIN [13]. Kumar and colleagues reported that CIN is distributed equally across all age groups [14]. In our study, the overall distribution of age among the studied samples was close to that of a previous study [15]. A study from Taiwan reported the mean age of patients with CCS was 67.6 ±13.0 years, which was much higher than our population [12]. This result proves the hypothesis stated previously that Bangladeshi people had CAD in their younger age [16]. The male-female ratio in our study was 3.6:1, very similar to the 3.5:1 reported previously [17]. This ratio between these two groups was not statistically significant. Female gender was reported as a risk factor for CIN in a previous study [18] and part of the CHA2DS2-VASc score [5].

This study found that the prevalence of hypertension, DM, dyslipidemia, smoking, and family history of CAD was 47%, 42%, 47%, 67%, and 54%, respectively. These findings were similar to a previous study in the same hospital by Rafiquzzaman et al. [19] except for smoking, which was 86% in their study. Over the years, the development of public awareness regarding smoking may be responsible for the reduction of the frequency. As expected, DM and hypertension were more prevalent in those with high (≥4) CHA2DS2-VASc scores (Group II) and statistically significant (p=0.005 and 0.04, respectively). Chaudhary and colleagues reported a statistically significant difference in DM and hypertension between those with scores <4 and ≥ ≥4 (p-value 0.0001 for both conditions) [20]. In our study, group II patients had lower ejection fraction in comparison to group I (p=0.0001), as previously reported [20].

The means of TC, LDL, TG and HDL were 169.07±39.04 mg/dl, 94.89±28.63 mg/dl, 136.52±33.74 mg/dl and 41.22±5.72 mg/dl, respectively. These values were 210 ± 50.3 mg/dl, 137.3 ± 46.2 mg/dl, 173.8 ± 169.8 mg/dl, and 40.1 ± 12.8 mg/dl, respectively, from a previous study [21], higher than our study. There was a significant difference in serum lipid profile between group I and group II. Chaudhary et al. [20] also found a statistically significant difference in the parameters between these two groups. Although the serum lipid profile is not a component of the CHA2DS2-VASc scoring system, higher values of these in group II can be explained by clustering multiple cardiovascular risk factors in the same patients, as evidenced by the Framingham Offspring study [22].

Both pre- and post-catheterization serum creatinine were higher in group II. In group II, 12 (24%) patients developed CIN, whereas only 4 (8%) patients in group I (p=0.029). The overall prevalence of CINs undergoing PCI was 16%. A previous study from Bangladesh reported 23 out of 250 patients developed CIN [23]. A Pakistani study also reported a prevalence of 10% who underwent PCI [13]. Chaudhary and colleagues found a prevalence of CIN of 4.8% and 56.8% in group I and group II, respectively [20]. This mismatch can be partially explained by the relatively lower proportion of group II samples (249 vs 51) in their study. In another study, where the sample size for group II was large (n=464), prevalence was 5.1% and 23.9% in groups I and II, respectively, very close to our study [24]. In Taiwan, PCI on patients with CCS revealed that those with a CHADS2 score >2 had a prevalence of CAD of 16.9% [12].

Conclusion

The CHA2DS2-VASc score is a simple, easy to use and cheap tool to predict development of CIN. In comparison to other risk assessment tools, it does not involve complex calculation and plenty of time. So, this score can be used as a quick tool, thus helps in better management and counseling of patients and relatives.

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