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Original Research Article

Association between contrast-induced nephropathy and CHA_2DS_2-VASc score in patient with non-ST elevation myocardial infarction after percutaneous coronary intervention

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ABSTRACT

Background: Contrast-induced nephropathy (CIN) is a recognized complication in patients with coronary artery disease (CAD) undergoing percutaneous coronary intervention (PCI). CHA2DS2-VASc score, commonly employed in clinical settings, shares similar risk factors for CIN development. This cross-sectional observational study investigated the association between CHA2DS2-VASc score and CIN post-PCI in non-ST segment elevated myocardial infarction (NSTEMI) patients.
Methods: Over one year (April 2019 to March 2020), 100 NSTEMI patients undergoing PCI at the national institute of cardiovascular diseases (NICVD), Dhaka, were included. Patients were categorized into two groups based on CHA2DS2-VASc scores (≥4, group I; <4, group II). CIN assessment utilized post-procedural serum creatinine within 48 hours, with statistical analysis performed using SPSS version 20.0.
Results: Group I exhibited a significantly higher CHA2DS2-VASc score (4.15±1.35 vs. 2.25±0.92 in group II). Post-procedural serum creatinine was notably elevated in CHA2DS2-VASc score ≥4 (1.98±0.46 vs. 1.46±0.27, p<0.001). A CHA2DS2-VASc score cut-off ≥4 predicted CIN with 84.6% sensitivity, 55.2% specificity (AUC 0.83, CI: 0.743-0.90, p<0.001).
Conclusions: This study establishes a significant association between CHA2DS2-VASc score and CIN in NSTEMI patients post-PCI, suggesting its potential utility in predicting CIN risk in this population.

Keywords: CHA_2DS_2-VASc score, CIN, NSTEMI, PCI

INTRODUCTION

Cardiovascular disease (CVD) is the most common cause of premature death in the world CVD accounts for 50% of all non-communicable disease (NCD) deaths in the world each year and represents a significant threat to human welfare and sustainable development.[1] Contrast media (CM) are being utilized more often in diagnostic

and interventional treatments. As a result, the prevalence of iatrogenic renal function impairment caused by CM exposure is increasing, a disorder known as CIN. Radiographic CM accounts for 11% of hospital-acquired renal insufficiency, making it the third most prevalent cause of renal failure after decreased renal perfusion and nephrotoxic drug usage. Coronary angiography and PCI have the highest incidence of CIN among all procedures that use Contrast medium (CM) for diagnostic or therapeutic purposes (CIN).[2,3] The most prevalent definition of CIN nowadays is a rise in serum creatinine of 25% or more, or an absolute increase of 0.5 mg/dl or higher, within 48 hours of CM exposure. The CHA2DS2-VASc scoring method includes congestive heart failure (CHF)/ left ventricular dysfunction, hypertension, age 75 years, diabetes mellitus, prior stroke, vascular disease, age 65 to 74 years, and sex (female). It has typically been used to predict the risk of stroke in people with atrial fibrillation.[4] The variables used in this score such as heart failure, hypertension, age, diabetes mellitus, and female sex are risk factors for poor clinical outcomes in CVDs.[5] Studies have shown the CHA_2DS_2-VASc score to have a good predictive value for adverse clinical outcomes in patients with CAD such as stable angina pectoris and acute coronary syndrome (ACS) with or without AF.[6] In patients with stable CAD as well as ACS, who undergo PCI, CIN is a known complication and is often associated with an increased 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 contrast media exposure.[9] The components of the CHA_2DS_2-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 scoring system was used in a recent study of NSTEMI undergoing elective PCI where it correlated well with the occurrence of CIN.[10] This study sought to analyze predictive value of CHA_2DS_2-VASc Score as a simpler tool for predicting CIN in patients with NSTEMI undergoing PCI.

Objective

General objective

General objective were to find out the association of CHA_2DS_2-VASc score with contrast-induced nephropathy after PCI in patients with NSTEMI.

Specific objectives

Specific objectives were to calculate the CHA_2DS_2-VASc score of NSTEMI patients, to assess the contrast-induced nephropathy after PCI in NSTEMI patients and to find out the relationship between CHA_2DS_2-VASc score and contrast-induced nephropathy after PCI in patients with NSTEMI.

METHODS

This cross-sectional observational study took place at the department of cardiology, NICVD, Dhaka, Bangladesh, spanning from April 2019 to March 2020. The study focused on patients presenting with NSTEMI undergoing PCI at NICVD during this period, totaling 100 patients selected through purposive sampling. Inclusion criteria encompassed patients admitted with NSTEMI scheduled for PCI who provided informed consent. Exclusion criteria comprised those with prior myocardial infarction, history of previous PCI or coronary artery bypass grafting (CABG), known chronic kidney disease, cardiomyopathy, cardiogenic shock, cardiac arrest at presentation, recent nephrotoxic drug exposure, recent radiographic contrast media exposure, and absence of initial or maximal serum creatinine data. Patients were categorized into two groups: group I with CHA2DS2-VASc score ≥4 (high risk) and group II with CHA2DS2-VASc score <4 (low risk), each comprising 50 patients. Informed written consent was obtained, and comprehensive investigations, clinical examinations, and data recording were conducted using predesigned structured questionnaire. Data analysis involved SPSS Version 20.0, with quantitative data expressed as mean and standard deviation, analyzed using the student t test. Qualitative data, presented as frequency and percentage, underwent comparison through chi-square ($\chi 2$) test. Differences in continuous variables between groups were determined by student t test or Mann-Whitney U test. Logistic regression analysis with the backward method identified independent predictors. A probability $p<0.05$ signified significance, while $p>0.05$ indicated insignificance. Ethical clearance was secured from the NICVD ethical review committee.

RESULTS

The mean age of the studied patients was 59.5±8.4years ranging from 45 to 76 years. The mean age of the group I patients was 60.3±9.3 years ranging from 45 to 76 years and the mean age of the group II patients was 58.6±7.5 years ranging from 45-75. The above table indicates that group I patients were older than group II patients and did not reach the statistical level of significance (p=0.31).

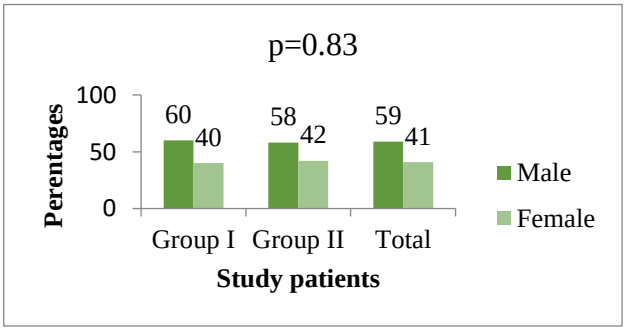

Figure 1: Gender distribution of study patients, (n=100).
P value reached from the chi-square test.

Table 1: Distribution of the study patients by age, (n=100)

Age (In years)	Group I, (n=50)		Group II, (n=50)		Total, (n=100)		P value
	N	%	N	%	N	%	
≤50	13	26.0	12	24.0	25	25.0	0.31^{ns}
51-60	7	14.0	16	32.0	23	23.0	
61-70	26	52.0	21	42.0	47	47.0	
>70	4	8.0	1	2.0	5	5.0	
Mean ± SD (Range)	60.3±9.3 (45-76)		58.6±7.5 (47-75)		59.5±8.4 (45-76)		

In this series, 59 (59%) patients were male and 41 (41%) patients were female. In group I, 60 (60%) patients were male and 40 (40%) patients were female. In group II, 29 (58%) patients were male and 21 (42%) patients were female. Male patients were predominant in the study. There was no significant association between group I and group II in terms of sex distribution (p=0.83) (Figure 1).

In group I, 62% of patients had a history of smoking, and 46% in group II with statistically insignificant association (p=0.10). History of hypertension and diabetes mellitus were significantly higher in group I than in group II (p<0.05). Dyslipidaemia was insignificantly higher in group I than in group II (p=0.30). Family history of CAD was higher in group I as compared to group II but failed to get statistical level of significance (p=0.25) (Table 2).

CHF was higher in group I as compared with II with a high significant difference (p<0.001). There were 2 patients aged>75 years in group I and no patients in group II with insignificant differences. Previous stroke was more in group I than II with significant difference (p=0.03). Vascular disease was found more in group I than in II with insignificant difference (p=0.31). Patients in age range 65-74 years were more in group I as compared with II but no significant difference. Female patients were found almost similar in both groups of patients with no significant difference (p=0.83) (Table 3).

Heart rate was insignificantly higher in group I compared to group II (73.2±5.6 vs 72.8±6.6 mmHg, p=0.67). Systolic blood pressure and diastolic blood pressure were found statistically non-significant differences between the study groups (p=0.51, p=0.49) (Table 4).

The mean creatinine of group I was 1.07±0.16 mg/dl and 1.96±0.44 mg/dl at baseline and after 48 hours respectively. It was statistically significant (p=0.001). It was also observed in group II that, 0.98±0.15 mg/dl and 1.06±0.17 mg/dl on baseline and after 48 hours respectively. This difference statistically not significant (p=0.08). Also implies that serum creatinine difference was higher in group I than in group II (Table 5).

It was observed that CIN occurred higher in group I (22%) than in group II (4%). A significant difference was observed in CIN in group I and II (p=0.02) (Table 6). Sensitivity and specificity of CHA_2DS_2-VASc score and occurring CIN. For occurring CIN sensitivity is 84.6% and specificity is 55.2% (Table 7).

Multivariate analysis revealed that out of the desired 5 variables previous stroke, Killip class≥2, and CHA_2DS_2-VASc-HS score >4 was found to be the independently significant predictors for CIN with ORs being 2.25, 2.47 and 2.89 respectively (Table 8).

Table 2: Distribution of the study patients by risk factors, (n=100).

Risk factors	Group I, (n= 50)		Group II, (n = 50)		Total, (n=100)		P value
	N	%	N	%	N	%	
Smoking	31	62.0	23	46.0	54	54.0	0.10^{ns}
Hypertension	40	80.0	21	42.0	61	61.0	<0.001^{s}
Diabetes mellitus	36	72.0	12	24.0	48	48.0	<0.001^{s}
Dyslipidaemia	23	46.0	18	36.0	41	41.0	0.30^{ns}
Family H/O CAD	9	18.0	5	10.0	14	14.0	0.25^{ns}

ns=Not significant (p>0.05), s=significant (p<0.05), p value reached from chi-square test and Fisher's exact test for frequency <5.

Table 3: Distribution of the study patients according to components of CHA_2DS_2-VASc score, (n=100)

Components	Group I, (n=50)		Group II, (n=50)		Total, (n=100)		P value
	N	%	N	%	N	%	
CHF (Killip≥ II)	31	62.0	12	24.0	43	43.0	<0.001^{s}
Age>75 years	2	4.0	0	0.0	2	2.0	0.49^{ns}
Previous stroke	8	16.0	1	2.0	9	9.0	0.03^{s}
Vascular disease	7	14.0	3	6.0	10	10.0	0.31^{ns}
Age 65 -74 years	26	52.0	20	40.0	46	46.0	0.22^{ns}
Sex (female)	20	40.0	21	42.0	41	41.0	0.83^{ns}

ns=Not significant (p>0.05), s=significant (p<0.05), p reached from chi-square test and Fisher's exact test for frequency <5.

Table 4: Distribution of the study patients according to clinical findings, (n=100).

Characteristics	Group I, (n=50)	Group II, (n=50)	P value
	Mean ± SD	Mean ± SD	
Heart rate/minute	73.2±5.6 (64-88)	72.8±6.6 (64-82)	0.67^{ns}
Systolic blood pressure (mmHg)	135.2±17.2 (90-150)	118.6±12.9 (90-150)	0.51^{ns}
Diastolic blood pressure (mmHg)	88.9±10.2 (70-95)	78.2±7.1 (60-90)	0.49^{ns}

ns= Not significant (p>0.05), p-value reached from unpaired t test.

Table 5: Changes in serum creatinine between baseline and after 48 hours among patients of study groups, (n=100).

Groups	Serum creatinine (mg/dl)		P value
	Baseline	After 48 hours	
	Mean ± SD	Mean ± SD	
Group I, (n=50)	1.07±0.16	1.96±0.44	0.001^{s}
Group II, (n=50)	0.98±0.15	1.06±0.17	0.08^{ns}

s=Significant (p<0.05), p value reached from paired t-test.

Table 6: Incidence of CIN among studied patients, (n=100).

Study groups	CIN				P value
	Developed		Not developed		
	N	%	N	%	
Group I, (n=50)	11	22.0	39	78.0	0.02^{s}
Group II, (n=50)	2	4.0	48	96.0	

s=Significant (p<0.05), p value reached from Fisher's Exact test.

Table 7. Sensitivity and Specificity analysis of CHA_2DS_2-VASc score >4 by CIN development, (n=100).

CHA_2DS_2-VASc-HS score	CIN, n (%)		Total
	Occurred	Not occurred	
Raised	11 (84.6)	39 (44.8)	50 (50)
Normal	2 (15.4)	48 (55.2)	50 (50)
Total	13 (100)	87 (100)	100 (100)

Table 8: Independent predictors of CIN multivariate binary logistic regression analysis, (n=100).

Variables of interest	OR	OR (95% CI)	P value
Hypertension	2.02	0.490-18.552	0.23^{ns}
Diabetes mellitus	2.14	0.519-11.475	0.25^{ns}
Previous stroke	2.25	1.217-16.235	0.03^{s}
Killip class≥2	2.47	1.321-22.245	0.01^{s}
CHA_2DS_2-VASc score >4	2.89	1.401-10.587	0.01^{s}

s=Significant (p<0.05), ns=Not significant (p>0.05), OR=Odds ratio

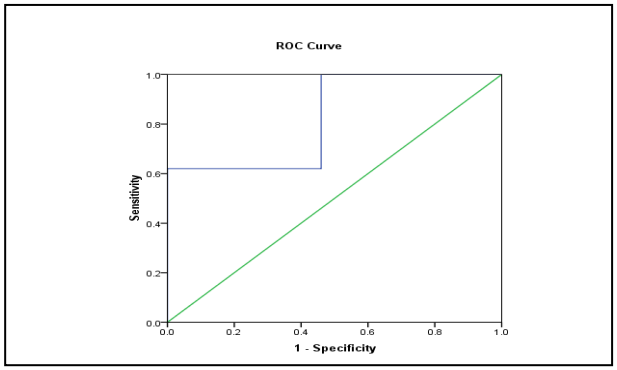

Figure 2: Receiver operating characteristic curves for CHA_2DS_2-VASc-HS score >4.

Table 9: ROC curves for CHA_2DS_2-VASc-HS score >4 in the prediction of developing CIN.

Area	Std. error[a]	Asymptotic sig.[b]	Asymptotic 95% CI	
			Lower bound	Upper bound
0.825	0.042	0.000	0.743	0.907

The area under the ROC curve for CHA_2DS_2-VASc-HS score >4 was 0.83 CI: 0.743-0.907, p<0.001) in the prediction of developing CIN among the study patients. It can be concluded that the prediction by regression analysis was significantly good with sensitivity and

specificity were 84.6% and 55.2% respectively (Figure 1 and Table 9).

DISCUSSION

The mean age of the studied patients was 59.5±8.4 years ranging from 45 to 76 years. Another similar study conducted by Chaudhury et al showed that the mean age of the study population was 55.04±9.55 years.[11] Although there was high frequency in group I there was no significant difference between the two groups in terms of smoking. one study showed that smokers have lower in-hospital mortality than non-smokers, a phenomenon called the "smokers' paradox".[12] However, the result of another study was consistent with the present study.[11] In hypertensive patients, there was a significant difference between the two groups. Another similar study showed the frequency of hypertension between two groups 77% vs 43% with a significant difference.[11] The same results were also concordant with another study.[10] Kurtul et al found a statistically significant difference between the two groups in terms of DM which was consistent with the present study.[12] Diabetic patients are known to have increased severity of nephropathy as well as higher rates for multivessel disease and more complex lesions such as long lesions, and bifurcation lesions.[13] Gokhan et al demonstrated that a family history of CAD was significantly higher in high CHA_2DS_2-VASc score than low CHA_2DS_2-VASc score (18% vs 10%) which was consistent with this study.[11] Patschan et al indicated that a family history of CAD is associated with the severity and extent of CIN.[14] The mean LDL cholesterol was 130.1±38.2 mg/dl. Chaudhary et al found that the mean LDL cholesterol was 135.31±39.83 which was compatible with this study.[11] About RBS, there was no significant difference between the two groups and it was similar to the study of Kurtul et al.[12] In the present study, the history of stroke was higher in group I than in group II with a statistical significant difference (p=0.03) and was compatible with other studies.[12,14] Moreover, vascular diseases were more common in group I than group II but statistically no significant difference (p=0.31) was found. The same results were also found in another study.[11] Cicek et al found, that there was a strong correlation between the degree of peripheral artery disease and CIN, but in this study vascular disease had no significant association with CIN may be due to less number of study subjects.[15] Studies have shown CHA_2DS_2-VASc score to have a good predictive value for adverse clinical outcomes in patients with CAD such as stable angina pectoris and ACS with or without AF.[6] In patients with stable CAD as well as ACS, who undergo PCI, CIN is a known complication and is often associated with an increased in-hospital and long-term morbidity including chronic renal dysfunction and mortality.[7] In this study, the burden of CIN was evaluated by CHA_2DS_2-VASc score. CHA_2DS_2-VASc score was significantly higher in group I than in group II. An almost similar result was demonstrated by another study where CHA_2DS_2-VASc score was 4.15±1.35 in high CHA_2DS_2-VASc score and 2.25±o.92 in low CHA_2DS_2-VASc score.[15] Post-procedural serum creatinine was significantly higher in patients with CHA_2DS_2-VASc score ≥4 (p<0.001), Another study showed that a high CHA_2DS_2-VASc score was associated significantly with high serum creatinine where a mean 1.96±0.44 vs 1.07±0.30 which was compatible with this study.[11] Here the high CHA_2DS_2-VASc score was associated with significant development of CIN which was 22%. Another study showed that a high CHA_2DS_2-VASc score was associated with significantly developed CIN which was similar to this study.[11] For the prediction of CIN cut the value of CHA_2DS_2-VASc score was ≥4 with a sensitivity of 84.6%, specificity of 55.2% (AUC 0.83, CI: 0.743-0.907, p<0.001), Relevant study showed similar results which was compatible to this study.[14]

Limitations

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

The development of CIN post-PCI in patients with NSTEMI is a frequent complication even in patients with normal renal function and is usually multifactorial. The course of CIN is mostly benign in patients with normal renal function. However, at times, there may be a progressive decline in renal functions mandating dialysis further adding to morbidity and cost of hospitalization. Hence, risk stratification and early identification of patients predisposed to CIN should be done. CHA2DS2-VASc score serves as a simple yet effective tool for predicting CIN pre-procedure which can be implemented in day-to-day clinical practice.

Recommendations

This study recommends that CHA_2DS_2-VASc Score is a novel predictor for CIN after PCI for NSETMI. Nevertheless, further studies with a large number of patients with a multicentre approach are needed to validate the result of this study.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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