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Original article

CHA2DS2-Vasc Score as a Novel Predictor for Contrast-Induced Nephropathy, Irrespective to Atrial Fibrillation, after Percutaneous Coronary Intervention in Acute Coronary Syndrome

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Abstract:

Background: Patients with acute coronary syndrome (ACS) undergoing percutaneous coronary intervention (PCI) are at particularly high risk of contrast-induced nephropathy (CIN), which, when occurring, may be followed by persistent worsening of renal function. The aim of this work was to validate CHA_2DS_2-VASc score as a novel predictor for contrast-induced nephropathy, irrespective to atrial fibrillation, after percutaneous coronary intervention in acute coronary syndrome. **Methods:** This was a single center, prospective cohort, non-randomized, observational study. This study included 200 patients with acute coronary syndrome who were planned for percutaneous intervention referred to the Department of Cardiology, Universal medical insurance tertiary hospital, Port Said, in the period between September, 2021 to January 2022. These patients were divided into two groups as: Group 1 (with CIN) and Group 2 (without CIN). **Results:** The current study showed that, CIN cases were significantly associated with higher CHA_2DS_2-VASc score when compared to those with no CIN. The optimal cut off value was 4, sensitivity was 75%, specificity was 71.4%, PPV was 33.3%, NPV was 93.7%, and accuracy was 72%. For the presence of CHA_2DS_2-VASc score <4, AUC for predicting CIN was 0.749 (sensitivity 62.5%, specificity 93.3%). For the presence of CHA_2DS_2-VASc score ≥4, AUC for predicting CIN was 0.807 (sensitivity 77.1%, specificity 86.8). **Conclusion:** CHA_2DS_2-VASc score has a positive predictive value being sensitive and specific for prediction of risk of CIN in population underwent PCI. Thus, CHA_2DS_2-VASc could be used easily in day-to-day clinical practice before PCI to give protective measures for patients at high risk.

Key words: CHA_2DS_2-VASc score; Novel predictor; Contrast-induced nephropathy; Percutaneous coronary intervention; Acute coronary syndrome

Introduction:

CHA_2DS_2-VASc is a composite scoring system comprising congestive heart failure/left ventricular dysfunction, hypertension, age≥75 years, diabetes mellitus, previous stroke, vascular disease, age 65–74 years, and sex(female). It has been traditionally used as a prediction tool for risk of stroke in patients with atrial fibrillation. These variables used in this score are risk factors for poor clinical outcomes in cardiovascular diseases. Studies have shown CHA_2DS_2-VASc score to have a good predictive value for adverse clinical outcomes in patients with coronary artery disease such as stable angina pectoris and acute coronary syndrome(ACS) with or without atrial fibrillation.[(1)]

In patients with stable coronary artery disease(CAD) as well as ACS, who undergo percutaneous coronary intervention(PCI), contrast-induced nephropathy(CIN) is a known complication and is often associated with an increased in-hospital and long-term morbidity including chronic renal dysfunction and mortality. The incidence of CIN ranges from 7% to 25% in different population subgroups based on the risk status. Hence, risk stratification has an important bearing to provide the appropriate preventive therapies to these high-risk individuals even before contrast media exposure.[(2)]

In the past, several risk prediction models have been proposed to envisage the CIN incidence. *The study conducted in 2004* [(3)] proposed a scoring system comprising eight variables which correlated well with the CIN risk.

The aim of this work was to validate CHA_2DS_2-VASc score as a novel predictor for contrast-induced nephropathy, irrespective to atrial fibrillation, after percutaneous coronary intervention in acute coronary syndrome.

Patients and Methods:

Study design:

It was a single center, prospective cohort, non-randomized, observational study that was conducted at the Department of Cardiology, Universal medical insurance tertiary hospital, Port Said.

Patient selection:

This study included 200 patients with acute coronary syndrome who were planned for percutaneous intervention referred to the Department of Cardiology, Universal medical insurance tertiary hospital, Port Said, in the

period between September,2021 to January 2022.

- All patients were prescribed a loading dose of aspirin 300 mg and clopidogrel 300 mg prior to the procedure. A dose of 70-100 U/kg of unfractionated heparin was given during the procedure and the use of glycoprotein IIb/IIIa receptor inhibitor and the type of stents was based on the physician's discretion [(5)].

These patients were divided into **two groups** as:

Group 1 (with contrast induced nephropathy (CIN)) and **Group 2(without CIN)**.

Contrast induced nephropathy was defined as increase in serum creatinine level ≥0.5 mg/dL or ≥25% increase from baseline within 48 h after PCI. [(6)]

Inclusion criteria :

Patients (of both genders) who was admitted with acute coronary syndrome, including both ST elevation myocardial infarction (STEMI) and non-ST elevation myocardial infarction (non-STEMI) who were planned for percutaneous intervention at Universal medical insurance tertiary hospital.

Exclusion criteria :

- Patients<18 ys old & >75 ys old.
- Patients with an estimated glomerular filtration rate (eGFR) < 30 mL/min, either with or without pre-existing dialysis, shock, acute renal failure, acute or chronic infection/inflammatory conditions, recent exposure to radio-graphic contrast media (within 10 days of enrollment), or having contraindications for PCI.
- Patients whose procedure was complicated by perforation or dissection.
- Patients who unfortunately died during or early after procedure or lack of data on serum creatinine during the 48 h after the procedure.

Methodology:

All patients were subjected to the following:

- **Complete personal history including:** Name, age, sex, occupation, special habits and risk factors for ischemic heart disease (smoking, diabetes, hypertension), family history of CAD, previous history of CAD or coronary artery bypass graft, previous atherosclerotic cerebrovascular events and current medical therapy.
- **Complete physical examination, including:**

A. Weight (in kg), height (in cm), body surface area (BSA)[(7)] in m^2.

BSA=[(height (in cm)+weight (in Kg)-60)]/100

B. Vital signs including body temperature, heart rate, respiratory rate and systolic and diastolic blood pressure.

C. Killip class at time of presentation.

Killip classification is widely used in patients presenting with acute MI for the purpose of risk stratification, as follows[8]**:**

- Killip class I includes individuals with no clinical signs of heart failure
- Killip class II includes individuals with rales or crackles in the lungs, S_3 gallop, and elevated jugular venous pressure
- Killip class III describes individuals with frank acute pulmonary edema
- Killip class IV describes individuals in cardiogenic shock or hypotension (measured as systolic blood pressure <90 mmHg), and evidence of low cardiac output (oliguria, cyanosis, or impaired mental status).

- **The following laboratory tests:**

A. Serum Creatinine,and eGFR was calculated using Cockcrofte Gault method: [9]

[140-age(years) × weight (kg)/72 × serum creatinine(mg/dl) [× 0.85 for female subjects]

Baseline serum creatinine was determined upon admission and was monitored for 48 hrs. and 7 days after the procedure to determine the occurrence of CIN.

B. Routine work up:

Complete blood count, blood urea, random blood sugar, glycated hemoglobin, serum sodium, potassium and fasting lipid profiles.

- **Electrocardiography**: 12 lead surface ECG was done for each patient.

- **Echocardiography**: Left ventricular ejection fraction was estimated by 2D echocardiography at admission using Simpson method ejection fraction

- **Calculating CHA_2DS_2-VASc score** for each patient as follows: [10].
- C for Congestive heart failure 1 point.
- H for Hypertension or high blood pressure 1 point
- A for Age greater than or equal to 75 years 2 points
- D for Diabetes mellitus or type 2 diabetes 1 point
- S for prior Stroke or TIA 2 points
- V for Vascular disease 1 point
- A for Age between 65 and 74 years 1 point
- S for female Sex 1 point

The maximum score for a CHA_2DS_2-VASc is nine.

Ethical consideration

This study gained the approval of the institutional ethic committee at faculty of medicine, Benha University no.#000125

Statistical analysis:

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Normality of data

- Kolmogorov Smerinov test was done to test the normality of data distribution.

Descriptive statistics:

- Mean, Standard deviation for parametric numerical data, while Median and range for non-parametric numerical data. Frequency and percentage of non-numerical data. Analytical statistics:
- Student T Test
- Mann Whitney Test (U test)
- Chi-Square test
- Fisher's exact test
- Correlation analysis
- The ROC Curve (receiver operating characteristic)
- Regression analysis

A *p* value is considered significant if <0.05 at confidence interval 95%.

Results:

Mean age of studied cases was 57.6 years; they were 116 males(58%) and 84 females(42%). Among them, 38.5% were smokers, 35.5% had DM, 49% had hypertension, 14.5% had CAD, 2% had renal diseases, 7.5% had PAD, 3.5% had S/P CABG and 4% had S/P CVA; 18.5% had KILLIP class>II **(Table 1)**.

Contrast—induced nephropathy occurred in 32/200(16%) patients**.**

Contrast—induced nephropathy was significantly associated with higher frequency of DM(46.9% versus 29.2%), hypertension(68.8% versus 45.2%), CAD(31.3% versus 11.3%), renal diseases(12.5% versus 0%), killip class>II(21.9% versus 17.9%) (p=0.049, 0.015, 0.003, <0.001, 0.592 respectively). Otherwise, no significant association was found regarding baseline demographic, history and clinical data of studied cases according to presence or absence of CIN (p>0.05 for each)**(Table 2).**

Table 3 shows that no significant differences were found regarding anthropometric

measures of studied cases according to presence or absence of CIN (p>0.05 for each).

Contrast—induced nephropathy cases were significantly associated with higher RBS(185.6 versus 15.7.6, p=0.032), HbA1C(8.2 versus 7, p=0.031), LDL(106.3 versus 82.7, p<0.001), TG(140.5 versus 124.2, p<0.001), lower eGFR pre-PCI (62.8 versus 93.2, p<0.001), serum creatinine 48 hrs.(1.5 versus 0.9, p<0.001) and serum creatinine 7 days after contrast(1.3 versus 1.1, p<0.01), when compared to those with no CIN. Otherwise, no significant differences were found regarding laboratory parameters of studied cases according to presence or absence of CIN **(Table 4).**

Contrast—induced nephropathy cases were significantly associated with lower LVEF when compared to those with no CIN (57.2±7.4 versus 50.3±7.2, p<0.001).

No significant differences were found between both groups regarding STEMI and NSTEMI
(Table 5).

Table 6 shows that CIN cases were significantly associated with higher contrast volume (mean=170.8± 45.5 ml vs 134.6±20.2 ml, p<0.001) and number of stents (median(min-max)=٢.5(1-3) vs ٢(0-3), p<0.001) when compared to those with no CIN.

Contrast—induced nephropathy cases were significantly associated with higher CHA_2DS_2-VASc score when compared to those with no CIN(median(min-max)=5(1-7) versus 3(1-7) respectively, p<0.001)**(Table 7)**.

Table 8 shows the receiver operating characteristic(ROC) curve of CHA_2DS_2-VASc score that was conducted for prediction of CIN.

Among all studied cases, CHA_2DS_2-VASc score showed moderate accuracy AUC (AUC=0.784). The optimal cut off value was 4, sensitivity was 75%, specificity was 71.4%, PPV was 33.3%, NPV was 93.7%, and accuracy was 72%.

For the presence of CHA_2DS_2-VASc score <4, AUC for predicting CIN was 0.749 (sensitivity 62.5%, specificity 93.3%) (**Figure 1).**

For the presence of CHA_2DS_2-VASc score ≥4, AUC for predicting CIN was 0.807 (sensitivity 77.1%, specificity 86.8) (**Figure 2).**

Logistic regression analysis was conducted for prediction of CIN susceptibility using age, gender, DM, hypertension, KILLIP, eGFR, metformin, ACEI/ARB use, contrast volume and CHA_2DS_2-VASc score as confounders. Presence of DM, hypertension, KILLIP>2, use of metformin, ACE inhibitor/ARB, lower eGFR, higher contrast volume, CHA_2DS_2-VASc score were associated with risk of CIN in univariable analysis. However, in multivariable analysis, only KILLIP>2, higher contrast volume, CHA_2DS_2-VASc score were considered independent predictors of CIN susceptibility (**Table 9).**

Table (1). Baseline demographic, history and clinical data of studied cases.

		Cases (n=200)
Age (years)	**mean±SD**	**57.6±6.7**
Males	**N (%)**	**116(58%)**
Females	**N (%)**	**84(42%)**
Smoking	**N (%)**	**77(38.5%)**
Diabetes mellitus	**N (%)**	**71(35.5%)**
Hypertension	**N (%)**	**98(49%)**
CAD	**N (%)**	**29(14.5%)**
Renal diseases	**N (%)**	**4(2%)**
PAD	**N (%)**	**١٥(7.5%)**
S/P CABG	**N (%)**	**٧(3.5%)**
S/P CVA	**N (%)**	**٨(4%)**
KILLIP class > II	**N (%)**	**37(18.5%)**

SD: Standard deviation; CAD: Coronary artery disease; PAD: Peripheral arterial disease; S/P CABG: Status post coronary artery bypass graft; S/P CVA: Status post cerebrovascular accident

		Group 1 (CIN) n=32	**Group 2 (No CIN) n=168**	***p***
Age (years)	**mean±SD**	57.6±6.1	57.6±6.8	0.991
Males	**N (%)**	18(56.3%)	98(58.3%)	0.827
Females	**N (%)**	14(43.8%)	70(41.7%)	
Smoking	**N (%)**	13(40.6%)	64(38.1%)	0.788
Diabetes mellitus	**N (%)**	15(46.9%)	49(29.2%)	**0.049**
Hypertension	**N (%)**	22(68.8%)	76(45.2%)	**0.015**
CAD	**N (%)**	10(31.3%)	19(11.3%)	**0.003**
Renal diseases	**N (%)**	4(12.5%)	0(0%)	**<0.001**
PAD	**N (%)**	١(3.1%)	14(8.3%)	0.473
S/P CABG	**N (%)**	٣(9.4%)	4(2.4%)	0.083
S/P CVA	**N (%)**	٢(6.3%)	6(3.6%)	0.617
KILLIP class > II	**N (%)**	7(21.9%)	30(17.9%)	0.592

SD: standard deviation; CAD: coronary artery disease; PAD: peripheral arterial disease; S/P CABG: Status post coronary artery bypass graft; S/P CVA: status post cerebrovascular accident

Table (3). Comparison of anthropometric measures of studied cases according to presence or absence of CIN.

		Group 1 (CIN)			**Group 2 (No CIN)**			***p***
		n=32			**n=168**			
BMI (kg/m^2)	**mean±SD**	26.3	±	4.2	28.0	±	4.8	0.069
SBP (mmHg)	**mean±SD**	119.7	±	25.2	125.4	±	24.7	0.235
DBP (mmHg)	**mean±SD**	75.0	±	14.6	76.2	±	13.6	0.645

SD: Standard deviation; BMI: Body mass index; RR: Respiratory rate; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: Heart rate

Table (4). Comparison of laboratory parameters of studied cases according to presence or absence of CIN.

		Group 1 (CIN) n=32			Group 2 (No CIN) n=168			*p*
Hemoglobin (g/dL)	mean±SD	13.0	±	2.0	12.8	±	1.7	0.617
RBS (mg/dL)	mean±SD	185.6	±	57.1	157.6	±	50.3	**0.032**
HbA1C (%)	mean±SD	8.2	±	1.9	7	±	1.6	**0.031**
TC (mg/dL)	mean±SD	216.5	±	36.7	211.0	±	33.4	0.539
HDL (mg/dL)	mean±SD	38.6	±	7.8	39.2	±	6.4	0.683
LDL (mg/dL)	mean±SD	106.3	±	11.7	82.7	±	11.2	**<0.001**
TG (mg/dL)	mean±SD	140.5	±	21.4	124.2	±	18.2	**<0.001**
CH/HDL	mean±SD	5.6	±	0.8	5.6	±	0.7	0.704
eGFR pre-PCI (ml/min)	mean±SD	62.8	±	5.9	93.2	±	19.7	**<0.001**
Serum Creatinine before contrast (mg/dL)	mean±SD	1.0	±	0.2	1.1	±	0.2	0.287
Serum Creatinine 48 after contrast (mg/dL)	mean±SD	1.5	±	0.4	0.9	±	0.1	**<0.001**
Serum Creatinine 7 days after contrast (mg/dL)	mean±SD	1.3	±	0.2	1.1	±	0.2	**<0.001**

SD: Standard deviation; RBS: Random blood sugar; TC: Total cholesterol; HDL: High-density lipoprotein; TG: Triglycerides; LDL: Low-density lipoprotein; eGFR: Estimated glomerular filtration rate; INR: International normalized ratio

Table (5). Comparison of ECG and echo results of studied cases according to presence or absence of CIN.

		Group 1 (CIN) n=32	**Group 2 (No CIN) n=168**	***p***
STEMI	**N (%)**	15(46.9%)	65(38.7%)	0.386
NSTEMI	**N (%)**	17(53.1%)	103(61.3%)	
LVEF (%)	**mean±SD**	50.3±7.2	57.2±7.4	**<0.001**

STEMI: ST elevation myocardial infarction; NSTEMI: Non-ST elevation myocardial infarction; LVEF: Left ventricular ejection fraction; SD: Standard deviation

Table (6). Comparison of PCI data of studied cases according to presence or absence of CIN.

		Group 1 (CIN)	Group 2 (No CIN)	*p*
		n=32	n=168	
Contrast volume (ml)	**Mean ± SD**	170.8±45.5	134.6±20.2	**<0.001**
Number of stents	**median (minimum-maximum)**	٢.5(1-3)	٢(0-3)	**<0.001**
	SD	0.07	0.8	

SD: Standard deviation

Table (7). Comparison of CHA_2DS_2-VASc score of studied cases according to presence or absence of CIN.

		Group 1 (CIN)	Group 2 (No CIN)	*p*
		n=32	n=168	
CHA_2DS_2-VASc score	**median (minimum-maximum)**	5(1-7)	3(1-7)	**<0.001**
	SD	1.7	1.2	

SD: Standard deviation

Table (8). ROC curve for CHA_2DS_2-VASc score for prediction of CIN.

	CHA_2DS_2-VASc score	**CHA_2DS_2-VASc score <4**	**CHA_2DS_2-VASc score ≥4**
AUC	0.784	0.749	0.807
Sensitivity (%)	75%	62.5	75
Specificity (%)	71.4%	93.3	77.1
PPV (%)	33.3%	99.3	86.8
NPV (%)	93.7%	14.2	60.7
Accuracy (%)	72%	64.4	75.7

AUC: area under ROC; ROC: receiver operating curve; PPV: positive predictive value; NPV: negative predictive value.

Table (9). Regression analysis for prediction of CIN susceptibility.

	Univariable				Multivariable			
	p	**OR**	**95% CI**		***p***	**OR**	**95% CI**	
Age	0.996	1.002	0.969	1.032				
Gender	0.798	1.057	0.692	1.613				
Diabetes mellitus	**0.014**	1.365	1.190	2.093	0.136	0.496	0.197	1.247
Hypertension	**0.017**	1.699	1.102	2.621	0.746	0.872	0.380	2.000
KILLIP class > II	**0.004**	1.474	1.195	1.984	**0.036**	1.387	1.129	1.928
eGFR pre-PCI	**<0.001**	0.820	0.710	0.929	0.283	0.809	0.758	1.493
Metformin	**0.018**	1.784	1.103	2.886	0.633	1.225	0.533	2.816
ACEi/ARB	**0.018**	1.784	1.103	2.886	0.247	1.011	0.993	1.029
Contrast volume	**<0.001**	1.023	1.014	1.032	**<0.001**	1.035	1.020	1.051
CHA_2DS_2-VASc score	**<0.001**	1.562	1.340	1.822	**<0.001**	1.577	1.238	2.008

eGFR: estimated glomerular filtration rate; ACEi: Angiotension converting enzyme inhibitor; ARB: Angiotension receptor blocker; OR: odds ratio; CI: confidence interval. Logistic regression test was used.

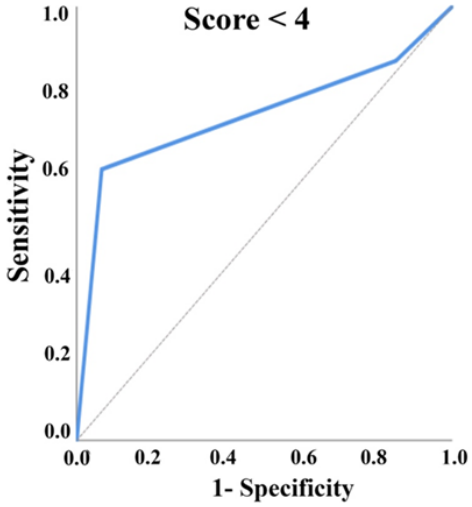

Fig. (1). ROC curve for CHA_2DS_2-VASc <4 score for prediction of CIN.

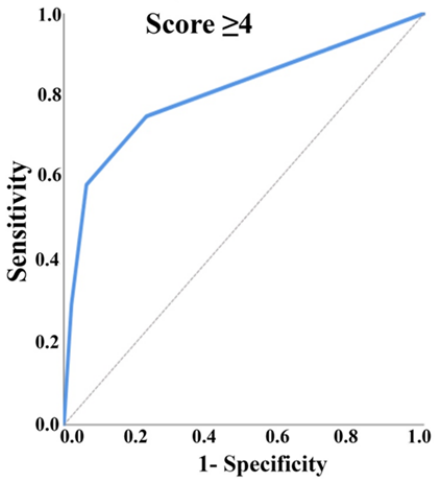

Fig. (2). ROC curve for CHA_2DS_2-VASc ≥4 score for prediction of CIN.

Discussion

Coronary artery disease (CAD), including acute coronary syndrome (ACS), remains the most common cause of death worldwide[16]. Thus, reperfusion therapy with intravenous fibrinolysis or percutaneous intervention (PCI) has become the primary goal in the management of ACS which makes patients undergoing PCI at high risk of contrast-induced nephropathy (CIN), which may lead to persistent worsening of renal function[17].

In the past, several risk predictions models have been proposed to anticipate the CIN incidence. Despite having a fair degree of accuracy, complexity was one of their major limitations. Since the CHA2DS2-VASc is widely used, questioning whether it can be useful to predict CIN, is unclear and because patients with ACS have a far greater risk for CIN compared to patients with stable CAD, its use as a predictive tool cannot be undermined[18].

This was a single center, prospective cohort, non-randomized, observational study. It included 200 patients with acute coronary syndrome who were planned for percutaneous intervention referred to the Department of Cardiology, Universal medical insurance tertiary hospital, Port Said, in the period between September, 2021 to January 2022. These patients were divided into two groups as: Group 1 (with CIN) and Group 2 (without CIN).

In the current study, contrast-induced nephropathy (CIN) incidence was about 16% among the studied population.

Contrast-induced nephropathy in the study conducted in 2019 [2] to assess the predictive role of CHA_2DS_2-VASc score for CIN in patients with ACS undergoing percutaneous coronary intervention (PCI), was reported in 41 patients (13.6%).

According to the study conducted in 2017 [4] which investigated the correlation between the CHA_2DS_2-VASc score and contrast-induced nephropathy in patients with ACS who underwent urgent percutaneous coronary intervention (PCI), it reported that a total of 159 patients were diagnosed with CIN within 48-72 hours after PCI, bringing the incidence rate to 11.3% in the study population.

In the current study, CIN was significantly associated with higher frequency of DM (46.9% versus 29.2%), hypertension (68.8% versus 45.2%), CAD (31.3% versus 11.3%), and renal diseases (12.5% versus 0%) (p=0.049,0.015, 0.003,<0.001 respectively).Otherwise, no significant association was found regarding baseline demographic, history and clinical data of studied cases according to presence or absence of CIN(p>0.05 for each).

This was in agreement with study conducted in 2019 [2] which demonstrated significant correlation between CIN and diabetes [29(70.7%) versus 33(12.7%)], hypertension [28(68.3%) versus 92(35.5%)], higher systolic blood pressure 148.39 ± 34.75 versus 134.32 ± 24.29, CHF as evident from (i)a higher Killip class [29 (70.7%) vs 25 (9.6%)] and (ii)a lower left ventricular systolic function.

This was also in accordance with the study conducted in 2014 [11] which investigated the relationship of patients' variables, including gender, CIN and mortality after primary PCI. They found that female gender (23(46.9) versus 69(25.2)), older age (18(36.7) versus 61(22.3)), diabetes (10(20.4) versus 45(16.4)), hypertension 24(49.0) versus 145(52.9), CHF, and renal dysfunction (1.2 ± 1.0 versus 1.0 ± 0.4) are well known risk factors for development of CIN (P value = 0.003, 0.05, 0.022, 0.001, 0.0001, 0.01 receptively). A reduced glomerular volume in women compared to their male counterpart has been proposed as a possible mechanism to explain a greater susceptibility to acute renal failure.

Our results showed that CIN cases were significantly associated with higher RBS (185.6 versus 157.6 p=0.032), HbA1C (8.2 versus 7, p=0.031), LDL(106.3 versus 82.7,p<0.001), TG(140.5 versus 124.2,

p<0.001), lower eGFR pre-PCI (62.8 versus 93.2, p<0.001), serum creatinine 48 hrs. (1.5 versus 0.9, p<0.001) and serum creatinine 7 days after contrast (1.3 versus 1.1,p<0.01) when compared to those with no CIN. Otherwise, no significant differences were found regarding laboratory parameters of studied cases according to presence or absence of CIN**.**

This was in concordance with the study conducted in 2014 ***(12)*** which reported that the use of an iso-osmolar contrast media in patients with a lower baseline eGFR was significantly associated with reduced CIN in their study. Hence, limiting the amount of contrast media used along with use of iso-osmolar contrast agents and adequate hydration may serve as a crucial strategy to limit the incidence of CIN in patients with known baseline reduced renal function.

In our study, CIN cases were significantly associated with lower LVEF when compared to those with no CIN (57.2±7.4 versus. 50.3±7.2) (P value <0.001). No significant differences were found between both groups regarding STEMI and NSTEMI (P value = 0.386).

This was consistent with the study conducted in 2014 ***(13)*** which found that patients with CHF are further at an increased risk for CIN as poor renal perfusion leads to a greater degree of renal vasoconstriction in adjunct with a low preload status in these subjects**.**

This was also supported by the study conducted in 2004 ***(3)*** which sought to develop a simple risk score of contrast-induced nephropathy (CIN) after percutaneous coronary intervention (PCI), that other predictors such as higher contrast volume were also found significantly correlated with risk of CIN (P value = 0.003), which are parts of Mehran risk model.

In the present study, CIN cases were significantly associated with higher contrast volume (mean=170 versus 134.6, p<0.001) and number of stents (median =2.5 versus 2, p<0.001). **(Table 6)**

When compared to those with no CIN these data were concurrent with the study done in 2017 ***(4)*** which found that multivessel CAD and multivessel PCI were the new predictors of CIN as established in their study probably due to the fact that a complete revascularization in these patients precluded a greater usage of radio contrast media. This

was carried out on 1408 patients with ACS undergoing urgent PCI (P<0.001).

Our results agreed with the study conducted in 2019 [2] which reported that higher contrast volume was significantly correlated with risk of CIN (P=0.001), which are parts of Mehran risk model [3].

The study done in 2019., [2] also reported that, multivessel CAD and multivessel PCI were the new predictors of CIN as established in their study probably due to the fact that a complete revascularization in these patients precluded a greater usage of radio contrast media (P=0.004).

The current study showed that, CIN cases were significantly associated with higher CHA_2DS_2-VASc score when compared to those with no CIN (median= 5 versus 3 respectively, p<0.001).

This was in agreement with the study conducted in 2016 [14] which investigated the association of the CHA_2DS_2-VASc-HSF score with the severity of CAD as assessed by SYNTAX score (SxS) in patients with ST segment elevation myocardial infarction (STEMI) and deducted that, $CHADS_2$ and CHA_2DS_2-VASc scores were found to be associated with both short- and long-term adverse clinical outcomes and mortality in patients with stable CAD and ACS. (Role of the $CHADS_2$ score in acute coronary syndromes: risk of subsequent death or stroke in patients with and without atrial fibrillation) (Predictive value of newly defined CHA_2DS_2-VASc-HSF score for severity of coronary artery disease in STEMI).

However, in our study, we used the CHA_2DS_2-VASc score instead of $CHADS_2$ as it's a more comprehensive tool and had been applied on patients with ACS rather than stable CAD.

Moreover, the study conducted in 2019 [2] reported that CHA_2DS_2-VASc score ≥4 is independently associated with the occurrence of CIN in patients with ACS treated by PCI (P=0.02).

Receiver operating characteristic(ROC) curve of CHA_2DS_2-VASc score was conducted for prediction of CIN in our study.

Among all studied cases in our research, CHA_2DS_2-VASc score showed moderate accuracy AUC (AUC=0.784). The optimal cut off value was 4, sensitivity was 75%, specificity was 71.4%, PPV was 33.3%, NPV was 93.7%, and accuracy was 72%. For the presence of CHA_2DS_2-VASc score

<4, AUC for predicting CIN was 0.749 (sensitivity 62.5%, specificity 93.3%). For the presence of CHA_2DS_2-VASc score ≥4, AUC for predicting CIN was 0.807 (sensitivity 77.1%, specificity 86.8) (**Figure 1 & 2**).

Our results were concordant with the study conducted in 2017 ***(4)*** which demonstrated that the adequate cut off score of CHA_2DS_2-VASc to predict CIN in ACS setting, was as follows, a score of 4 was highly predictive of developing CIN.

The study conducted in 2019 (2) also determined the adequate cutoff score of CHA_2DS_2-VASc to predict CIN in ACS setting. A score of ≥4 was highly predictive of developing CIN (P= 0.0001).

Moreover, we reached the same result as the study conducted in 2015 ***(15)*** which found that CHA_2DS_2-VASc score due to its ease of usage permits us to predict the occurrence of CIN in patients with ACS and implement prophylactic measures (intravenous hydration) before contrast exposure to prevent CIN.

Conclusion:

CHA_2DS_2-VASc score has a positive predictive value being sensitive and specific for prediction of risk of contrast-induced nephropathy in a population which underwent PCI. Thus, CHA_2DS_2-VASc could be used easily in day-to-day clinical practice before PCI to give protective measures for patients at high risk.

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