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Value of the CHA2DS2-VASC score in predicting patients with persistent complete occlusion having percutaneous coronary intervention to develop nephropathy caused by contrast

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Abstract
Background: CIN, a significant complication occurring post-PCI, particularly affects individuals with chronic total occlusions. It is crucial to identify people at risk for CIN early on in order to improve clinical outcomes and save medical expenses. Patients with atrial fibrillation have their embolic risk assessed using the CHA2DS2-VASC score and has demonstrated potential in forecasting various cardiovascular incidents. Nevertheless, its applicability in predicting CIN among CTO patients undergoing PCI has not been thoroughly investigated.
Aim: This study aims to evaluate the predictive power of the CHA2DS2-VASC score for the incidence of CIN in patients undergoing CTO PCI.
Methods: 60 CTO patients underwent PCI at Benha University Hospital in a prospective observational study. Each participant's CHA2DS2-VASC score was determined prior to the intervention. Those with a significant rise in serum creatinine (≥0.5 mg/dL or a 25% elevation) within 48 hours of PCI were assigned to the CIN group, whereas those without such an increase were assigned to the non-CIN group. To investigate the correlation between CHA2DS2-VASC scores and CIN, logistic regression was employed. The ROC curve was used to evaluate the score's predictive potential.
Results: 18 (30%) of the 60 patients developed CIN post PCI. The median CHA2DS2-VASC Risk Score was 1.93 (ranging from 1 to 5). With a significantly higher median CHA2DS2-VASC Score (4.0) than the non-CIN group (2.5), a p-value of 0.001 suggested increased cardiovascular risk for individuals with CIN, while a CHA2DS2-VASC Risk cut-off value of ≥4 provided the highest diagnostic accuracy, having an area under the curve (AUC) of 0.842, a specificity of 66.7%, and a sensitivity of 83.3%.
Conclusion: Among patients having PCI for chronic complete occlusions, the CHA2DS2-VASC score strongly predicts contrast-induced nephropathy. Due to its straightforward calculation and robust predictive power, the CHA2DS2-VASC score can be seamlessly incorporated into clinical practice for assessing pre-procedural risks and informing preventive measures. To validate these findings in more extensive, multi-center investigations, more investigation is required.

Keywords: CHA2DS2-VASC score, contrast-induced nephropathy, chronic total occlusion, percutaneous coronary intervention, risk stratification

Introduction

One significant and prevalent complication arising from cardiac interventions, contrast-induced nephropathy (CIN) is common, especially in patients with chronic complete occlusion (CTO) and during percutaneous coronary procedures (PCI) involving complicated lesions.

This complication is associated with prolonged hospitalizations, increased financial burdens, greater utilization of medical resources, and elevated morbidity and mortality rates [1].

Persistent complete blockage the incidence of CIN is considerably greater in PCI operations. There are two main kinds of risk factors that are responsible for the development of CIN:

patient-related factors, which include chronic renal failure, diabetes, advanced age, hyperuricemia, anemia, dehydration, hypoproteinemia, prior kidney transplantation, and the administration of nephrotoxic medications such as diuretics or aminoglycosides; and

procedural-related factors, which encompass the volume and characteristics of the contrast agent used, the performance of two or more consecutive procedures within a 72-hour period, and the utilization of an intra-aortic balloon pump [2]. Numerous studies have been undertaken to elucidate the risk factors linked to this complication. Nonetheless, there remains a paucity of data regarding the interplay between various parameters, such as vascular access, duration of the procedure, and the CHADS2VASC2 score, as they relate to the risk of developing CIN in patients with chronic total occlusion [3]. The CHA2DS2-VASC risk score was initially created to assess embolic risk in patients with atrial fibrillation in order to optimize anticoagulant therapy [4].

Long-term PCI results and coronary artery disease can be predicted by the risk score [5]. The reliability of the CHA2DS2-VASC risk score's capacity to predict contrast-induced nephropathy in PCI patients is questionable due to its broad adoption [6]. According to evidence, this scoring system can predict CIN post-PCI in patients with acute coronary syndrome [7].

The usefulness of the CHA2DS2-VASC risk score in predicting CIN development in CTO-PCI patients remains uncertain.

Patients and Methods

This investigation was carried out in Benha University Hospital as a prospective observational study in the period from 9/2022 to 9/2023. This study included 60 patients with documented CTO lesions and underwent elective revascularization,

- Next, patients were split into two groups according to whether CIN had occurred after PCI:
- CIN patients make up Group I.
- Patients in Group II do not have a CIN.

Inclusion criteria

- Age > 18
- During elective PCI, patients suffering from one or more chronic total occlusions (CTOs) in their coronary arteries. That were defined as Coronary lesions with TIMI flow grade 0, and must be present for at least three months to be classified as Chronic Total Occlusions (CTOs) [8]. The length of occlusion was ascertained by analysing angiography data, preceding MI, and the start of angina. Clinical variables such as the initial onset of angina, a history of myocardial infarction (MI) in the target vascular location, or comparison with an earlier angiography were utilized to determine the length of occlusion.

Exclusion criteria

The following patients were excluded from the study:

- Patients with anemia (<12.0 g/dL in females and <13.0 g/dL in males).
- Patients with severe blood loss (> 2,000 mL).
- Patients with hypotension (<90/60 mmHg).
- Patients with end-stage renal failure. (GFR < 15 mL/min).
- Patients with recent myocardial infarction.
- Patients with unstable hemodynamic condition.
- Use of LV assists device.
- Use of intra-aortic balloon pump.
- Patients with contraindications to anti platelet therapy.
- Patients who had recent contrast exposure before elective PCI within 48hrs.

Study procedure

The following applied to each patient

Taking a complete medical history: Age, gender, Smoking, hypertension, DM, dyslipidaemia and Family history of premature CAD.

Hypertension (HTN) is characterized by blood pressure readings of more than 130 mmHg in systole or more than 80 mmHg in diastole, as well as prior or ongoing antihypertensive drug treatment. -Stage 1: 130–139 mmHg systolic or 80–89 mmHg diastolic is the classification for hypertension. Stage 2: systolic pressure of 140 mmHg or greater, or diastolic pressure of 90 mmHg or more. Stage 3: A systolic pressure of 180 mmHg or a diastolic pressure of 120 mmHg or greater [9].

Diabetes Mellitus (DM) is defined as: Random blood glucose test ≥200 mg/dL, Fasting plasma glucose test ≥ 126 mg/dL, Oral glucose tolerance test ≥ 200 mg/dL, or HbA1c test ≥ 6.5 or higher. The condition can also be caused by elevated blood glucose levels [10].

The following were included in the clinical examination

Arterial systolic and diastolic blood pressure, heart rate and pulse assessment.

Calculation of CHA2DS2-VASC risk score: According the following table (1) [11]:

Table 1: The CHA2DS2-VASc score [11]

Letter	Risk factor	Score
C	Congestive heart failure/LV dysfunction	1
H	Hypertension	1
A_2	Age ≥75	2
D	Diabetes mellitus	1
S_2	Stroke/TIA/thrombo-embolism	2
V	Vascular disease*	1
A	Age 65–74	1
S	Sex category (i.e., female sex)	1
	Maximum score	9

Congestive heart failure/LV dysfunction means LV ejection fraction ≤40%. Hypertension includes the patients with current antihypertensive medication. *Prior myocardial infarction, peripheral artery disease, aortic plaque. LV: left ventricular, TIA: transient ischemic attack

- **12 lead-surface ECG:** To exclude recent ischemia and significant arrhythmias.
- **Laboratory data:** Full labs especially; especially Baseline creatinine, 24 and 48 hours after procedure & CBC.
- **Standard conventional 2-D Echocardiography:** Echo-Doppler examination was performed to all patients pre-PCI using vivid e echocardiography machine equipped with 3S-RS probe with simultaneous ECG signal. Patients were examined in the left lateral decubitus using all accessible windows and different views (apical and parasternal long and short axes),The modified Simpson technique (biplane method of discs) was utilised to measure regional wall motion abnormality (RWMA) and compute Left Ventricle Ejection Fraction (LVEF). This modality requires area tracings of the LV cavity. This approach to LVEF measurement is advised by the American Society of Echocardiography [12].
- **Coronary angiography data:** Patients underwent elective PCI to CTO according to the current up-to-date guidelines and precautions, all patients received proper loading dose of antiplatelet (clopedogrel or ticagrelor) before the procedure and proper dose of heparin during the procedure guided by Activated Clotting Time (ACT), and all patients received low osmolality non-ionic contrast during the elective PCI [13]. We evaluated the following parameters: vascular access (femoral or radial or both) used, amount of contrast media used, any complication during and post procedure e.g. bleeding, malignant arrhythmia, procedure total time, baseline TIMI& final TIMI to the culprit vessel and Restoring TIMI antegrade flow grade 3 and achieving less than 30% residual diameter stenosis within the treated segment were deemed satisfactory results of the CTO procedure [14].
- **Follow-up:** To identify the presence of CIN, serum creatinine was measured 24 and 48 hours following the surgery.

Results

Table 2 displayed the characteristics of every subject that was investigated.

The incidence of Contrast-Induced Nephropathy (CIN) was 30%. Patients were then divided into two groups (table 3, 4) based on whether CIN had occurred after PCI: Group I consisted of 18 patients (30%), while Group II consisted of 42 patients (70%), who had not had CIN.

Table 2: Characteristics of the study population

Variable	Count and percentage
Age (years), median (range)	34-76 (59.48)
Sex, N (%)	60 (100%)
F	9 F (15%)
M	51 M (85%)
Risk factors, N (%)	60 (100%)
Smoking	32 (53.3%)
Hypertension	42 (70%)
DM	30 (50%)
Dyslipidemia	32 (53.3%)
Family history of IHD	23 (38.3%)
History of CVS	5 (8.3%)
History of HF	10 (16.7%)
History of CKD	18 (30%)
CHA2DS2-VASC Risk Score (CVRS): median (range)	1-5 (1.93)
History of abnormal bleeding, N (%)	6 (10%)
Vascular access, N (%)	60 (100%)
Right RA	18 (30%)
Right FA	54 (90%)
Left FA	11 (18.3%)
Culprit Artery	
LAD	23 (38.8%)
LCX	5 (8.3%)
RCA	32 (53.3%)
Contrast volume (ml), median (range)	120-700 (295)
Procedure time (min), median (range)	40-260 (139)
Successful reperfusion	28 (46.7%)
Baseline creatinine (mg/dl), median (range)	0.4-1.4 (0,94)
Creatinine at 24 h (mg/dl), median (range)	0.5-2.5 (1.07)
Creatinine at 48 h (mg/dl), median (range)	0.6-2.7 (1.28)
CIN N (%)	18 (30%)

Comparison between two groups was done in regards to the following

Demographic data and risk factors

The two groups did not differ statistically significantly in terms of gender (P-value=0.2341) or age (67 vs. 52.26 years, P-value= 0.1923). There were eight girls (44.4%) and ten men (55.6%) in Group I. There were 41 men (97.6%) and 1 woman (2.4%) in Group II. (Listing 3)

There were no variations seen between the two groups with respect to the risk factors. Twelve patients (66.7%) from group I and eighteen patients (42.9%) from group II had a history of diabetes mellitus (P-value= 0.1297). History of HTN was found in 16 patients (88.8%) of group I vs. 2 patients (4.8%) of group II (P value=0.0526). 6 patients (33.3%) of group I were smokers vs. 26 patients (61.9%) of group II (P-value= 0.1601). Dyslipidemia was found in 9

patients (50%) of group I vs. 23 patients (54.8%) of group II (P-value= 0.0526). (Table 3)
Although history of CVS, HF & CKD were higher in group I, they were statistically insignificant{5 (28%) vs. 0 (0%), 6 (33%) vs. 4 (9.5%) & 3 (17%) vs. 2 (4.8%) with p value> 0.05}. (Table 3)
With a p-value of 0.001, group I's median CHA2DS2-VASC Score was considerably greater (4.0) than group II's (2.5), suggesting that individuals with CIN may be at increased risk of cardiovascular events. (Table 3)

Table 3: Comparison of patients with or without CIN according demographic data

Variable	Group I CIN (n=18) (30%)	Group II Non-CIN (n=42) (70%)	P- value
Age (years), median (range)	67	56.2619047619048	0.1923
Sex, N (%)			
F	8 (44%)	1 (2.4%)	
M	10 (56%)	41 (97.6%)	
Risk factors, N (%)			
Smoking	6 (33%)	26 (61.9%)	0.1601
Hypertension	16 (89%)	2 (4.8%)	0.0526
DM	12 (67%)	18 (42.9%)	0.1297
Dyslipidemia	9 (50%)	23 (54.8%)	0.0526
History of CVS	5 (28%)	0 (0%)	0.1901
History of HF	6 (33%)	4 (9.5%)	0.1944
History of CKD	3 (17%)	2 (4.8%)	0.2627
CHA2DS2-VASC Risk Score (CVRS): median (range)	2-7 (4.0)	0-4 (2.5)	0.001

Laboratory and Angiographic data
Baseline creatinine levels showed a statistically significant difference between the groups under study. Patients in group I had a mean baseline creatinine level that was significantly higher (1.15±0.27 mg/dl) than patients in group II (0.87±0.22 mg/dl), with a p-value of less than 0.001, suggesting that patients with higher baseline creatinine are more likely to develop CIN. (Table 4)
Culprit Artery: With a p-value of 0.003, a far greater percentage of patients in group I (66.7%) than in group II (26.2%) had the LAD identified as the culprit artery. This could be due to the fact that interventions on the LAD often involve more complex and extensive procedures, potentially leading to greater contrast use and longer procedure times. (Table 4) While The RCA was the culprit artery in a significantly smaller proportion of patients in group I (27.8%) compared to those of group II (64.3%), with a p-value of 0.009, This could be due to the relative simplicity or shorter duration of procedures involving the RCA, resulting in less contrast exposure.
Group I had a considerably greater median contrast volume (339 vs. 276 ml, p = 0.0014) than Group II. Also the median procedure time was statistically significant higher I group I (136 vs. 129 min with p value= 0.0042); suggesting that longer and more complex procedures might contribute to the development of CIN. (Table 4)
The angiography outcome showed that patients in group I had a reduced successful reperfusion rate: 7 patients (38.9%) in group I compared to 21 patients (50%) in group II had TIMI 3 flow. This difference was statistically significant (p=0.0037), suggesting that CIN may have an impact on the effectiveness of the procedure. (Table 4). (Figure 1)

Table 4: Comparison of patients with or without CIN according laboratory and angiographic data

Variable	Group I CIN (n=18) (30%)	Group II Non-CIN (n=42) (70%)	P- value
Baseline creatinine (mg/dl), Mean±SD (range)	0.8 -1.7 (1.15±0.27)	0.4 - 1.2 (0.87±0.22)	<0.001**(a)
History of abnormal bleeding, N (%)	1 (5.5%)	5 (11.9%)	0.1491
Vascular access, N (%)			
Right RA	6 (33.3%)	12 (28.6%)	
Right FA	15 (83.3%)	39 (92.9%)	
Left FA	2 (11.1%)	9 (21.4%)	
Culprit Artery			
LAD	12 (66.7%)	11 (26.2%)	0.003*
LCX	1 (5.6%)	4 (9.5%)	0.0169
RCA	5 (27.8%)	27 (64.3%)	0.009*
Contrast volume (ml), median (range)	160-560 (339)	120-700 (276)	0.0014
Procedure time (min), median (range)	45-260 (163)	40-250 (129)	0.0042
Successful reperfusion	7 (38.9)	21 (50%)	0.0037

†. Mann-Whitney test
‡. Fisher's exact test
§. Pearson chi-squared test
(a): Independent-Sample T Test

The CHA2DS2-VASC Risk Score was shown to be substantially (p<0.001) linked with the occurrence of CIN in the univariate logistic regression analysis, suggesting that a higher score is a good predictor of CIN. Other factors, such as the quantity of contrast volume used, the procedure time,

and the baseline serum creatinine, did not separately demonstrate any significant relationships (table 6).

The sole independent predictor of the development of CIN after PCI, according to the multivariate logistic regression analysis, was the CHA2DS2-VASC Risk Score (hazard ratio = 4.071, 95% CI: 1.686-9.832, p-value = 0.002; table 6).

Table 5: Univariate and multivariate Logistic regression analysis for predictable parameters for occurrence of CIN:

	Univariate		#Multivariate	
	P	OR (LL-UL 95%C.I)	p	OR (LL-UL 95%C.I)
CHA2DS2-VASC Risk Score	<0.001**	4.184 (1.791-9.776)	0.002*	4.071 (1.686-9.832)
Contrast volume	0.245	1.003 (0.998-1.007)		
Procedure time	0.362	1.005 (0.994-1.015)		
Baseline creatinine	0.120	0.378 (0.101-0.856)		

LL stands for lower limit, UL for upper limit, C.I. for confidence interval, and OR for odds ratio. *: All variables with p<0.05 were included in the multivariate analysis. At p < 0.05, statistically significant

Using a ROC curve, the diagnostic value (total accuracy) of the CHA2DS2-VASC Risk Score in predicting the existence of CIN after PCI was evaluated. The CHA2DS2-VASC Risk cut-off value ≥4 was shown to have the highest diagnostic accuracy (sensitivity = 83.3%, specificity = 66.7%, area under the curve (AUC) = 0.842). (Table 7). (Fig. 1)

Table 6: Receiver operating characteristic (ROC) curves analysis of CHA2DS2-VASC Risk Score (CVRS) to discriminate between the CIN patients (n= 18) and non-CIN patients (n = 42):

Parameters	AUC	P	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
CHA2DS2-VASC Risk Score	0.842	<0.001**	0.735-0.949	≥4.0	83.3%	66.7%	85.37%	63.16%

AUC: Area under a curve, p-value: Probability value, CI: Confidence Intervals, NPV: Negative predictive value, PPV: Positive predictive value, CVRS: CHA2DS2-VASC Risk Score, *: Statistically significant

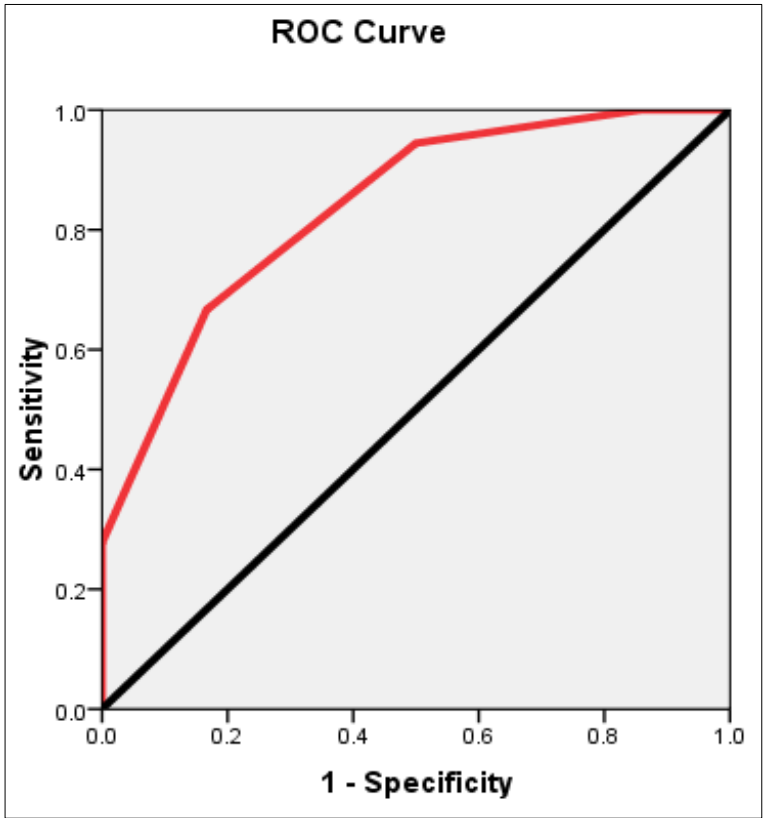

Fig 1: ROC curves analysis of CHA2DS2-VASC Risk Score (CVRS) to discriminate between the CIN patients (n= 18) and non-CIN patients (n = 42)

Discussion

One of important and common complications of cardiac interventions especially in PCI with complex lesions and CTO patients is the development of CIN. This complication results in longer hospital stays, increase in financial burden, increase in medical resources, higher morbidity and mortality rates (1).

New risk factors linked to this issue have been found via a number of additional research. However, information about the relationship between several parameters, such as vascular access, time of surgery, and CHADS2VASC2, as risk factors for the development of CIN in chronic total occlusion (CTO) is still lacking (3).

In order to assess the predictive efficacy of the CHA2DS2-

VASC score as a pre-procedural indicator of contrast-induced nephropathy in CTO patients having PCI, this study was conducted.

Incidence of CIN

Of the participants in our research, 18 patients (30%) experienced CIN. In comparison, 100 patients with coronary artery disease who had PCI throughout the study period were evaluated by (Valappil *et al*., 2018) [15]. Two-thirds of cases were CIN. Our findings diverge from those reported by Azzalini *et al*. (2016) [16], who conducted a retrospective analysis involving 2,660 patients (n = 1,128 for complex PCI and n = 1,532 for non-complex PCI). According to their research, the incidence of contrast-induced nephropathy (CIN) was 11.5% in patients undergoing non-complex PCI and 12.1% in patients undergoing complicated PCI. Complex PCI was characterized by at least one of the following criteria: treatment of three vessels, implantation of three or more stents, bifurcation interventions involving two stents, total stent length exceeding 60 mm, protective PCI, left main procedures, saphenous vein grafts, rotational or laser atherectomy, or PCI used on a chronic complete blockage. The discrepancy between their results and our study may be attributed to the fact that all cases in our investigation involved highly complex chronic total occlusions (CTOs), which necessitate greater contrast volume and longer procedural times, thereby elevating the risk of CIN.

Predictors of CIN

In our results, The LAD was identified as the culprit artery in a significantly higher proportion of patients with CIN with a p-value of 0.003. While The RCA was the culprit artery in a significantly smaller proportion of patients with CIN, with a p-value of 0.009. This was concordant to Abdelhameed *et al*., 2023 [17] use 200 STEMI patients as a sample who were undergoing primary percutaneous coronary intervention. The left anterior descending artery (LAD) was found to be the main causative artery in patients with contrast-induced nephropathy, with a p-value of 0.001. In our study, Patients of CIN group had substantially higher baseline creatinine levels, procedure time and amount of contrast volume than those of non-CIN group (p value<0.05). Similar to our study, Werner *et al*., 2021 [22] who examined the frequency of acute kidney injury linked with contrast after chronic complete occlusion was recanalized, found that patients with CIN required longer fluoroscopy times (46.1 min vs. 37.6 min, p=0.005) and also detected that pre-existing chronic kidney disease stage ≥ 2 was predictor of post PCI Contrast-nephropathy in patients with chronic total occasion. Concordant to our study, (Yurdam *et al*., 2023) [18]; an analysis of 110 patients with CTO who had been diagnosed with chronic coronary syndrome using retrospective observational research revealed that patients with CIN after PCI used more opaque material than those without CIN (242±33 vs. 200±22 ml, P=0,001), and their PCI sessions lasted longer (81±20 vs. 65±18 minutes, P=0,001). Also, Wang *et al*., 2019 [19] who evaluated CHA2DS2 VASC score as a pre-procedural predictor of CIN among patients with CTO undergoing PCI. They revealed that duration of coronary intervention (PCI) was longer in patients with CIN vs. these without CIN post PCI (120±48 vs. 91±50 minutes, P=0,001) & total amount of contrast was higher in patients with CIN vs. these without CIN post PCI (299±105.2 vs. 227.1±98.3 ml, P=0,001). On the other hand, our results were discordant with (Sheng Lin *et al*., 2014) [21] they examined the impact of clinical factors, interventional methods, and CTO lesion characteristics on renal function in order to estimate the probability of acquiring CIN in patients receiving CTO PCI. They detected that both procedural duration and fluoroscopic time (minute) was non-significant between CIN and non-CIN group (99.6±41.4 min vs. 101±46.8min and 43.1±26.8 min vs. 41±24.4min, respectively p>0.05), this may be due to larger sample size as they included 516 CTO patients.

CHA2DS2-VASC risk score

Our investigation found that, with a p-value of 0.001, the average CHA2DS2-VASC risk score was much greater in the CIN group (4.0) than in the non-CIN group (2.5), indicating a higher risk of cardiovascular events in individuals who developed CIN. The greatest diagnostic accuracy was found with the CHA2DS2-VASC Risk Score cut-off value of ≥4 (sensitivity = 83.3%, specificity = 66.7%, and area under the curve (AUC) = 0.842). According to Wang *et al*., 2019(19), the mean CHA2DS2-VASC Risk Score in the CIN group was significantly higher than that of the non-CIN group (3.1±1.2 VS. 2.1±1.1, p <0.001), and in CTO patients, the AUC was 0.742 (Sensitivity=69.2%, specificity=78.0%, 95% CI = 0.682-0.797& P value <0.001), indicating that CHA2DS2-VASC Risk Score ≥3 was an independent predictor of CIN.

Furthermore, Chaudhary *et al*., 2019 [20] agreed with our investigation. AUC=0.81, 95% CI 0.73-0.90) showed that CHA2DS2-VASC Risk Score ≥ 4 was an independent predictor for CIN, and that the mean CHA2DS2-VASC Risk Score was greater in the CIN group (4.15±1.35 vs. 2.25±0.92, p< 0.0001). Once more, this was in line with the findings of Khalil *et al*., 2023 [23] who evaluated the CHA2DS2-VASC Risk Score's added value to safe contrast volume for the prediction of CIN following PCI. The patients were split into two groups according on how their CIN developed after PCI. They demonstrated that the CIN group had a higher mean CHA2DS2-VASC Risk Score [4(1-7) vs. 2 (0-7), p <0, 0001].

The optimal threshold value for the CHA2DS2-VASC Risk Score was > 3 with an AUC of 0.73, sensitivity of 66.67%, specificity of 69.91%, and 95% accuracy for identifying CIN in patients treated with either elective PCI or primary PCI. P <0.001 and CI = 0.67-0.78.

Conclusion

The results highlight the need of pre-procedural risk assessment using baseline serum creatinine levels and the CHA2DS2-VASC Risk Score. Patients with CTO lesions are reliably identified as having an increased risk of CIN after elective PCI if they have a CHA2DS2-VASC Risk Score of ≥4. The amount of contrast utilised and the length of the operation are other variables that increase the risk of CIN following CTO surgery.

Limitation

The study faces some limitations, including a limited sample size in subgroup analyses (e.g., gender differences), missing data on key CIN risk factors like hydration status, and a short follow-up period that may not capture long-term outcomes. Additionally, the study's definition of CIN relies solely on serum creatinine levels, without assessing other factors such as proteinuria or kidney morphology.

Recommendation

The CHA2DS2-VASC Risk Score is proposed as an easy, effective tool for predicting CIN risk in CTO patients undergoing elective PCI, making it suitable for routine

clinical practice. Managing contrast volume and procedure duration is advised to reduce CIN risk. Future research should focus on larger studies for broader validation and explore gender-related differences in CIN risk and post-PCI outcomes.

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Conflict of Interest: Nil

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