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Association of Pre-Procedure Microalbuminuria with Development of Contrast-Induced Nephropathy among Patients with Acute Coronary Syndrome Undergoing Percutaneous Coronary Intervention

Md. Kamrul Hasan[1*], Mohammad Badiuzzaman[2], AKM Mohiuddin Bhuiyan Masum[3], K.A.M. Mahbub Hasan[4], Tanvir Adnan[5], Ayesha Siddika[6], Syed Mahmud Ali[7], Nahidul Hasan[8], Shamim Chowdhury[9]

Abstract

Patients undergoing percutaneous coronary intervention (PCI) are at high risk for development of contrast induced nephropathy (CIN). Urinary albumin excretion is one of the earliest biomarkers of kidney injury and it is associated with deterioration of renal function after PCI in the patients with acute coronary syndrome (ACS). The aim of this study was to assess the relation between pre procedure microalbuminuria and development of CIN among the patients with ACS undergoing PCI. This Cross-sectional analytical study was carried out in the department of cardiology, National Heart Foundation Hospital and Research Institute from August 2021 to July 2023 (one year). This study assigned 164 consecutive patients present with ACS undergoing PCI and categorized into two groups according to albumin excretion status Microalbuminuria and Normoalbuminuria. Microalbuminurea (MA) is defined as urinary Albumin-creatinine ratio (UACR) of 30- 300mg/gm creatinine in random spot urine sample. Effectiveness of relation between pre procedure microalbuminuria and development of CIN was analyzed using a receiver operating characteristic (ROC) curve. In this study out of 164 patients,67(41%) patients were microalbuminuria and 97 (59%) were normoalbuminuric. Mean Urinary ACR was found 73.75 ±5.6 in microalbuminuria group and 16.24 ±6.43 in normoalbuminuria group. In microalbuminuria group CIN was developed in 24 (36%) patients and CIN did not develop in 43 (64%) patients, in normoalbuminuria group 15 (16%) patients had developed CIN and 82 (84%) patients did not develop CIN. Receiver-operator characteristic (ROC) were constructed using urinary ACR of the patients with CIN positive, which gave a urinary ACR cut off value of (≥23.17mg/g) as the value with a best combination of sensitivity and specificity for CIN positive were found to be 74.0% and52.8% respectively. Microalbuminuria is an important biochemical parameter for prediction development of CIN among patients with ACS undergoing PCI.

Affiliation:

[1]Assistant Registrar, Department of Cardiology, National Institute of Cardiovascular Disease, Dhaka, Bangladesh

[2]Professor, Department of Cardiology, National Heart Foundation Hospital & Research Institute, Dhaka, Bangladesh

[3]Professor & Head, Department of Cardiology, Popular Medical College and Hospital, Dhaka, Bangladesh

[4]Assistant Professor, Department of Cardiology, National Institute of Cardiovascular Disease, Dhaka, Bangladesh

[5]Junior Consultant, Department of Cardiology, Popular Medical College and Hospital, Dhaka, Bangladesh

[6]Specialist, Department of Cardiology, United Hospital Limited, Dhaka, Bangladesh

[7]Registrar, Department of Cardiology, Ibrahim Cardiac Hospital and Research Institute, Dhaka, Bangladesh

[8]Medical Officer, Department of Cardiology, National Institute of Cardiovascular Disease, Dhaka, Bangladesh

[9]Registrar, Department of Cardiology, National Heart Foundation and Research Institute, Dhaka, Bangladesh

***Corresponding author:**

Md. Kamrul Hasan, Assistant Registrar, Department of Cardiology, National Institute of Cardiovascular Disease, Dhaka, Bangladesh.

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Introduction

In 2020, approximately 19.1 million deaths were attributed to cardiovascular disease (CVD) globally. The age-adjusted death rate per 100,000 population was 239.8, and the age-adjusted prevalence rate was 7,354.1 per 100,000. The highest mortality rates attributable to CVD in 2020 were in Eastern Europe and Central Asia, with higher levels also seen in Oceania, North Africa and the Middle East, Central Europe, Sub-Saharan Africa, and South and Southeast Asia. Rates were lowest for locations in high-income Asia Pacific and North

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America, Latin America, Western Europe, and Australasia [1]. Globally, it was estimated that in 2020, 244.1 million people were living with ischemic heart disease (IHD), and it was more prevalent in males than in females (141.0 and 103.1 million people, respectively). In 2020, North Africa and the Middle East, Central and South Asia, and Eastern Europe had the highest prevalence rates of IHD. IHD mortality rates were 112.37 per 100,000 and were highest in North Africa and the Middle East, Eastern Europe, and Central Asia [1]. Bangladesh has experienced a significant increase in the prevalence of noncommunicable chronic diseases and associated mortality over the last few decades [2,3]. Urbanization and lifestyle changes—such as sedentary behavior, changes in dietary habits including increased access to processed foods, irregular meal patterns, and reduced physical activity—further increase the risk of chronic diseases [4]. Despite ongoing improvements in interventional cardiology, in-hospital mortality remains high after primary percutaneous coronary intervention (PCI) among patients with certain types of ST-elevation myocardial infarction (STEMI). Predictors of in-hospital mortality among patients with acute coronary syndrome (ACS) include Killip class, systolic blood pressure, heart rate, cardiac arrest, older age, prior heart failure, prior myocardial infarction (MI), peripheral arterial disease, chronic kidney disease (CKD), and elevated initial serum creatinine levels [5,6]. Urinary albumin excretion is an early biomarker of kidney injury that reflects endothelial dysfunction and increased glomerular permeability. It is independently associated with short- and long-term adverse outcomes in patients with and without diabetes or hypertension, identifying high-risk individuals for cardiovascular disease [7,8]. Contrast-induced nephropathy (CIN) is the third leading cause of in-hospital acute kidney injury and is associated with an increased risk of MI, dialysis, and death [9,10]. Even small increases in serum creatinine are linked to longer hospital stays and higher costs. Accordingly, multiple studies emphasize CIN prediction and prevention as a major healthcare priority, as therapeutic options are limited once CIN develops [11-13]. CIN after PCI is common, especially in patients presenting with ACS, due to hemodynamic instability and inadequate prophylaxis [14,15]. Factors contributing to CIN in patients without preexisting kidney disease include hemodynamic instability, thromboembolic events, adverse drug reactions, type and volume of contrast media, osmolarity, and lack of preventive measures [16]. Risk factors for CIN include low eGFR, older age, diabetes mellitus, and dehydration [17,18]. Baseline impaired renal function, expressed as elevated serum creatinine or low GFR, is a recognized independent predictor of CIN [19]. The development of CIN post-PCI in ACS patients is frequent and usually multifactorial. While the course is mostly benign in patients with normal renal function, CIN in ACS patients is associated with increased in-hospital and long-term morbidity, including chronic renal dysfunction and mortality. Therefore, risk stratification and early identification of patients predisposed to CIN are essential.

Methods and Materials

Study type: Cross sectional analytical study.

Study place: Department of Cardiology, National Heart Foundation Hospital and Research Institute (NHF&RI).

Study population: Patients who were admitted with ACS and underwent PCI during the study period & fulfill exclusion and inclusion criteria.

Study period: The study was carried out from August 2021 to July 2023 (one year) in the Department of Cardiology, NHFH & RI.

Sample size formula: $n = \frac{z^2pq}{d^2}$

n= desired sample size.

z =standard normal deviation, usually set at 1.96 which correspond to 95%confidence level.

p =proportion in target population estimated to have a particular characteristic=0.121 proportion of CIN in microalbuminuria patients undergoing PCI [20].

q = 1-p, proportion in target population estimated not to have a particular characteristic.

Considering inclusion and exclusion criteria a total number of 164 patients of both sexes were included in the study.

Inclusion Criteria:

- All adult patient presented with acute coronary syndrome who underwent percutaneous coronary intervention at NHFH & RI during the study period.

Exclusion Criteria:

- Acute coronary syndrome patients with macroalbuminuria.
- Acute coronary syndrome patients with haemodynamicinstability (Cardiogenic shock, acute left ventricular failure)
- Chronic coronary syndrome patients undergoing PCI.
- Patients with acute kidney injury or known case of chronic kidney disease.
- Non-steroidal anti-inflammatory drugs (NSAIDs) or other nephrotoxic drugs use within 48 h before the procedure
- Concomitant of severe liver dysfunction.
- Patients presenting with malignancy, infectious diseases, thyroid dysfunction, and coagulation disorders.
- History of contrast medium exposure within the past 2 weeks.
- Unwilling to give consent.

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Grouping of study subject

These patients were divided in two groups.

Group I: Patient with microalbuminuria (uACR 30-300 mg/g).

Group II: Patient with normoalbuminuria (uACR< 30 mg/g).

Study procedure: After obtaining approval from the ethical committee of our hospital, this cross-sectional analytic study was carried among the patients undergoing PCI within the study period. Patients with ACS fulfilling the inclusion and exclusion criteria were included in this study. In this process, a total of 164 were enrolled in our study. Informed written consent has been taken from each patient before enrolment. All demographic data & detailed history and clinical data were recorded. 12 lead ECG was obtained from all patients at admission and Echocardiographic evaluation in the first 24 hours following admission. Blood sample was collected for Hs Troponine I, NT-pro BNP, fasting lipid profile, complete blood count (CBC), Serum creatinine, Serum Na, K+, before the percutaneous coronary intervention. The Modification of Diet in Renal Disease formula was used to calculate eGFR. Measurement of Pre procedure microalbuminuria by urinary albumin craetinine ratio (uACR).

Coronary angiography and PCI were performed by an expert intervention team, according to the standard clinical practice from published guidelines. The primary endpoint was the development of CIN after the procedure. Post-procedure Serum creatinine was measured at least 48 hours after the procedure. Contrast-induced nephropathy was defined by a 25% relative increase, or a 0.5 mg/dL (44 mmol/L) absolute increase, in serum creatinine (SCr) within 48-72 hr of contrast exposure, in the absence of an alternative explanation.

Measurement of uACR: We collected a random urine sample before Percutaneous Coronary Intervention. Urinary albumin concentration was measured by turbidimetric immunological technique, using Dimension EXL with LM Integrated Chemistry System. Urinary ACR was calculated and reported as mg/g creatinine.Patients with urinary albumin levels less than 30 mg/g of creatinine were defined as having normoalbuminuria, those with urinary albumin levels 30 - 300 mg/g as having uACR significant consider as microalbuminuria.

Statistical analysis: After collection, data were entered, checked, and analyzed in Statistical Package for Social Sciences (SPSS) for Windows, version 23.0 (IBM, USA). Results were shown as Table and Figures and expressed as frequency and percentage for qualitative data and mean ± SD for quantitative data and compared by Chi-square test for qualitative variables and unpaired student's t-test for quantitative variables where was applicable. 'p' value <0.05 was considered as statistically significant. Receiver operating characteristic (ROC) curve was done for the prediction of CIN by pre procedure urinary ACR to the study population. Multivariate logistics regression model was done to evaluate whether the association between microalbuminuria and contrast-induced nephropathy persisted.

Results

A total of 164 consecutive patients have been included in this study among them 67 patients developed microalbuminuria and 97 patients were normoalbuminuric. Based on the albuminuria status patients were divided into two group.group I patients with microalbuminuria and group II patients with normoalbuminuria. Data were presented in tabular form and graphs (Pie chart) , Unpaired student's t test, chi-square test, multivariate logistic regression for the variables were done. Receiver operating characteristic curve were done to obtain the cutoff value of urinary ACR for CIN prediction. Observations and results of the study were as follows.

Table 1 showing age Distribution among the study population. Majority of patients were in the age range of > 60 years equal in both group and Majority of patients were 51-60years in group II compare to group I. The mean (±SD) age was group I 55.53± 11.66 compare to group II 54.38±10.71 which statistically not significant (p<.05).

Table 1: Age Distribution of the study population according to albuminuria status (n=164).

Demographic characteristics	Group I (n=67) n(%)	Group II (n=97) n(%)	p-value
Age in years			
30-40 years	7(36.8)	12(63.2)	
41-50 years	17(40.5)	25(59.5)	0.373ns
51-60 years	17(33.4)	34(66.6)	
> 60 years	26(50)	26(50)	
Mean ±SD	55.53±11.66	54.38(±10.71)	0.514ns

In Figure 1, Pie diagram showing 40.90 % of total population had urinary ACR > 30-300 mg/g which were in group I and rest 59.10 % had urinary ACR < 30 mg/g were in group II.

Table 2 Showing distribution of risk factors between two groups were statistically not significant (p>0.05) except Diabetes mellitus which was more in group I compare to group II and became statistically significant (p<0.05).

Table 3 Showing association clinical diagnosis of the study patients between two groups not became statistically significant (p>0.05).

Table 4 Showing distribution of Comparison of biochemical variables between two groups Among them Hb%, NT-pro-BNP were statistically significant (p>0.05).

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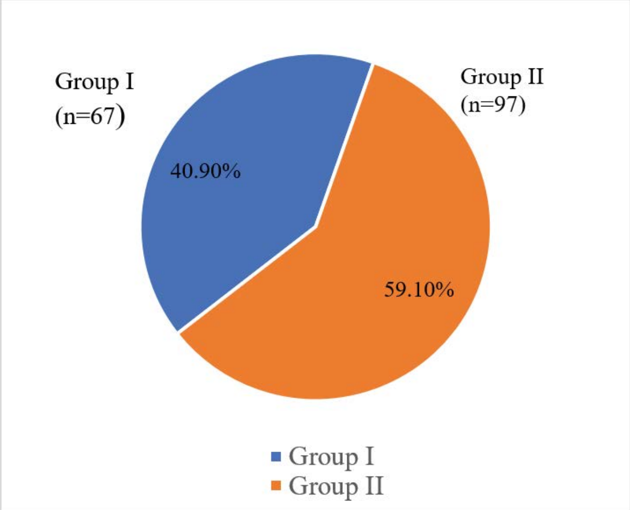

Figure 1: Pie diagram showing Distribution of the study population according to albuminuria status (n=164).

Table 2: Association between Risk factors the study population according to albuminuria status (n=164).

	Group I(n=67)	Group II (n=97)	P value
	n(%)	n(%)	
DM	31(46.3)	24(24.7)	0.004^{s}
Hypertension	36(53.7)	55(56.7)	0.707^{ns}
Dyslipidemia	16(23.9)	17(17.5)	0.318^{ns}
Smoking	42(62.7)	58(59.8)	0.709^{ns}
BMI (kg/m^2)			
Mean ±SD	25.77±2.6	26.11±2.72	0.443^{ns}

Table 3: Distribution of the study population according to clinical diagnosis (n=164).

Diagnosis	Group I(n=67)	Group II (n=97)	P value
	n(%)	n(%)	
STEMI	39(58.2)	41(42.3)	0.115^{ns}
NSTEMI	25(37.3)	52(53.6)	
UA	3(4.5)	4(4.1)	

Table 4: Comparison of biochemical variables among the study population (n=164).

Laboratory and Echocardiography variables	Group I (n=67)		Group II (n=97)		p value
	Mean	±SD	Mean	±SD	
Hb%	11.17	±1.13	11.73	±1.16	0.003^{s}
eGFR	81.11	±14.82	82.98	±17.61	0.479^{ns}
NT-Pro-BNP	387.31	±92.72	214.14	±89.64	0.001^{s}
Serum Troponin I	29.92	±14.46	30.08	±14.81	0.954^{ns}

Table 5 Showing Serum creatinine 48 hours after procedure wereincreased ingroup I compare to group II which became statistically significant ($p<0.05$).

Table 6 Showing utilized dye volume (mean ±SD) which were more in group I compare to group II were statistically significant ($p<0.05$) and number of treated vessels two groups not became statistically significant ($p>0.05$).

The Table 7 showing with development of CIN were more in group I compare to group II were statistically significant ($p<0.05$).

Table 5: Comparison of Mean Urinary ACR and S.creatinine before and 48 after procedure of the study population (n=164).

	Group I(n=67)		Group II (n=97)		P value
	Mean	±SD	Mean	±SD	
urinary ACR	73.75	±5.6	16.24	±6.43	
Serum creatinine before procedure	1.17	±0.14	1.15	±0.14	0.376^{ns}
Serum creatinine 48 hours after procedure	1.46	±0.33	1.28	±0.30	0.001^{s}

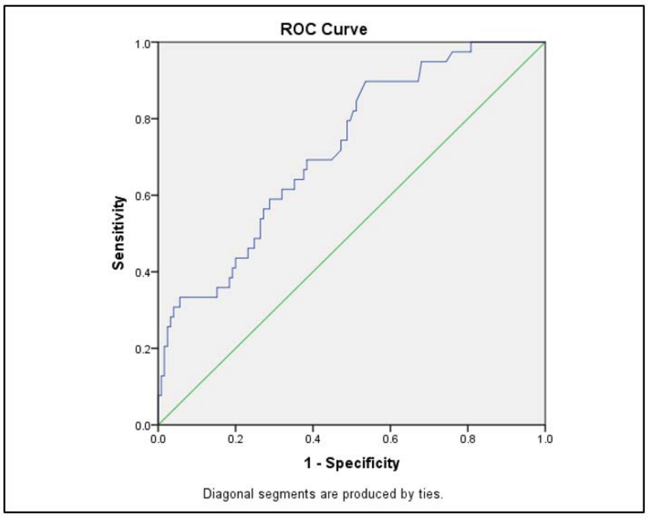

Figure 2: Showing Receiver operating characteristic curve (blue line) for measurement pre procedure urinary ACR applied to the study population. Receiver operator curve (ROC) showing the area under the curve (AUC) is 0.721 (95% CI;0.634-0.809).

Table 6: Mean difference of utilized dye volume andnumber of treated vessels to the study population (n=164).

	Group I(n=67)	Group II(n=97)	P value
	Mean ±SD	Mean ±SD	
Dye volume	97.69 (±3.29)	93.84 (±3.92)	0.001^{s}
Single vessel PCI	37(55.2%)	56(57.8%)	0.267^{ns}
Multivesssel PCI	30(44.8%)	41(42.2%)	

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Table 7: Distribution of development of CIN among study population (n=164).

	CIN developed	CIN did not developed	P value
	n(%)	n(%)	
Group I(n=67)	24(35.8)	43 (64.2)	
Group II (n=97	15(15.5)	82(84.5)	0.003s
Total (n=164)	39(23.8)	125(76.2)	

Table 8: Receiver operating characteristic (ROC) curve of urinary ACR for prediction of CIN.

	Cut of value	Sensitivity	Specificity	Area under the	95% Confidence interval (CI)	
				ROC curve	Lower bound	Upper bound
Urinary ACR	≥23.17	74	52.8	0.721	0.634	0.809

The area under the receiver-operator characteristic (ROC) curves for the CIN positive predictors is depicted in Table 8. Based on the receiver-operator characteristic (ROC) curves Urinary ACR had the best area under curve. Receiver-operator characteristic (ROC) wereconstructed using Urinary ACR of the patients with CIN positive, which gave a urinary ACR cut off value of (≥23.17 mg/g) as the value with a best combination of sensitivity and specificity for CIN positive were found to be 74.0% and 52.8%, respectively.

Discussion

In our study majority of the patient from the age group of > 60 years. Among the common risk factors for coronary artery disease were collected by asking close-ended questions and observing previous medical records, 46.3 % patient were diabetic, 53.7% were Hypertensive, 23.9% had a history of treated dyslipidemia, 62.7% were a smoker and mean BMI was 25.77±2.6 among the patients who had microalbuminuria. In the present study, the study participants had a predominance of the age group of >60 years. In group I mean age was 55.53 (±11.66) years compare to group II 54.38(±10.71) years. Ali et al. [21] showed almost similar mean age in microalbuminuric patients. Anwar et al. [22] showedmean (±SD) age of patients who developed CIN was significantly higher compared to patients who did not develop CIN 58.17±9.20 and 52.32±10.88 years similar to our study [23-31]. Adetunji et al. [32]showed mean age were 62 years in microalbuminuric patients. Meng et al. [20] foundstatistically significant between microalbuminuric and normoalbuminuic patients in relation to mean age. Though some other studies showed a higher mean age at patient developed microalbuminuria may be due to geographical variations, racial, ethnic differences, and genetic causes that have a significant influence on coronary artery disease in their study subjects. The reasons for the higher risk to develop microalbuminuria in the elderly were not studied specifically and probably are multifactorial, including age-related changes in renal function (diminished glomerular filtration rate, tubular secretion, and concentrating ability). In a study done by Victor et al. [24] they showed that diabetes is associated with microvascular consequences like retinopathy or neuropathy and it is a strong predictor of microalbuminuria which may lead to CIN. In this study 31(46.3%) patients in group I were diabetic and 24 (24.7%) were diabetic group II findings are statistically significant which is similar to the results of Anwar et al. [23], Islam et al. [25], Meng et al. [20], Chowta et al. 26] and Al-Maskari et al. [27].The difference may be due to dietary habits, lifestyle, family history, level of physical activity, and socio-cultural variation.Hypertension is a well-known risk factor for CKD but in the case of microalbuminuria, it is different. In this study, 36(53.7%) patients had hypertension in group I, and 55(56.7%) in thepatient group II which was statistically not significant within groups which is similar to the results of Islam et al. [25] and Mridha et al. [28]. Liu et al. [29] showed statistical significance between two group in hypertensive patients.In this study, dyslipidemia was found in group I 16(23.9%) and group II 17(17.5%) which was not statistically significant within groups showed simillar results Anwar et al. [22], Mridha et al. [28] and Siddike et al. [31] as ours. Other common risk factors smoking also did not differ significantly between the groups.Obesity is associated with metabolic syndrome which can be a cause of microalbuminuria. In this study, obesity was found in group I 5(13.4%) and group II 13(7.5%) which was not statistically significant within groups and results were similar to Mridha et al. [28] and Meng et al. [20] and Ali et al. [21]. In our study Hb% was found in group I 11.17 and group II 11.73 it was found statistically significant Adetunji et al. [32] has simillar results as ours. Liu et al. [30] in their study found thatanemia is an independent risk factor for CIN in all patients' microalbuminuria.In this study mean eGFR in the patient group I it was 81.11(±14.82) ml/min/1.73 kg/m^2 compare to patient in group II 82.98(±17.61) ml/min/1.73 kg/m^2 which is not statistically significant between groups.which is similar to the study populations of Chowta et al. [26] but Adetunji et al. [32] and Meng et al. [20] found statistically significant results in between group. Zhou et al. [33] stated that association between NT-pro BNP and microalbuminuria is uncleared but when diabetic patients had vascular complication, they had increase level of NT-pro-BNP. In our study mean NT-pro-BNP in the patient with group I it was 387.31(±92.72) pg/ml compare to patients group II 214.14(±89.64) pg/ml which was statistically significant within groups. Zhou et al. [33] had found positive association NT-pro-BNP and microalbuminuria. Liu et al. [29] found in their study LV dysfuntion in the microalbuminuric group associated greater severity of diabetes which is an important predictor of CIN. In our study LV dysfunction was more found in group I and normal LV systolic function were in

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group II and it was also statistically significant within groups which is similar to Anwar et al. [22] and Liu et al. [29] had found LV dysfuntion more in microalbuminuria group. Wang et al. [34] stated that medullary hypoxia and direct tubular toxicity of contrast media are accepted as the main pathophysiological mechanism of CIN. Greater amount of contrast media put a more risk of CIN. In our study mean contrast volume (ml) used in the patient group I it was 97.69(±3.29) ml compare to group II 93(±3.92) ml which is statistically significant between groups similar to Anwar et al. [22] studies. Among other PCI related variables Multivessel PCI did not differ significantly between groups similar to Islam et al. [25] studies. Meng et al. [20] reported that microalbuminuria is associated with increased oxidative stress, decreased levels of nitric oxide, endothelial dysfunction, and tubular reabsorption dysfunction, uACR in between (30 -300 mg/g) were associated significantly with the development of post-contrast acute kidney injury in patients undergoing coronary catheterization which similar to our study where mean uACR 73.75(±5.6) mg/g in group I compare to patient in group II 16.24(±6.43) mg/g is statistical significant. Eugenio et al. [35] showed that the best CIN related uACR cutoff value was 20 mg/g. Contrast-induced nephropathy was significantly higher when the ACR was ≥ 20 mg/g compared to when it was < 20 mg/g (≥ 9.6% vs 1.6%, respectively, P< .001).Vicente-Vicente et al. [36] showed that microalbuminuria high risk factor for renal function deterioration after contrast CM administration even in preserve renal function.in our study 24(35.8%) patients were in group I to developed CIN and 15(15.5%) patients in group II who developed CIN, among all patients (n=250),39 developed CIN. overall incidence was 23.8 %.the result was statistically significantsimilar to result Zaman et al. [37], Siddike et al. [31], Anwar et al. [22] and Ma et al. [38] who found that urinary ACR levels were higher in patients who developed CIN 45.71% as compared to normoalbuminuria group 11.03% (P < 0.001).This agrees with Meng et al. [20] had found similar type of result (12.1% vs 5.0% respectively, p<.005). A receiver operating characteristic curve (ROC curve) for pre procedure uACR was applied to the study population. The receiver operator curve (ROC) showing the area under the curve (AUC) is 0.721 (95% CI;0.634-0.809). The cutoff value of uACR for CIN prediction was ≥ 23.17 with a sensitivity of 74.0% and a specificity of 52.8%. The key findings of this study are the following (1) Microalbuminuria correlated with development of CIN. (2) After adjustment for baseline risk, patients in the higher uACR remained at increased risk of CIN compared with the reference group. Early evaluation of the risk of CIN after PCI can help to identify patients who may profit from prevention strategies and close follow-up. The assessment of uACR may constitute a cost-effective and easy tool to predict the risk of post procedural CIN.

Conclusion

According to results of this study it indicated that,Microalbuminuric patients present with acute coronary syndrome undergoing percutaneous coronary intervention are more prone to developed contrast induced nephropathy.

Limitations

This study had some limitations though the study results supported the hypothesis. The limitations of the study were as follows:

1. The study was conducted in a single tertiary care hospital (Department of Cardiology, National Heart Foundation Hospital and Research Institute) which may not represent the general population.
2. Short term and long-term mortality and morbidity were not seen.
3. Majority study population were male.

Recommendations

- CIN negatively impacts prognosis of hospitalized and long-term outcome of patients.So CIN should be accurately predicted to avoid this unwanted complication.
- Microalbuminuria obtained through uACR is an established predictor for endothelial dysfunction also becomes a marker of CIN in patients with ACS with an added value in a widely validated clinical score.
- Besides clinical risk factors and available risk scores for predicting CIN Microalbuminuria can also be an important tool for CIN prediction.

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