Brain Natriuretic Peptide as a Predictor of Contrast- Induced Nephropathy in Patients with Acute Coronary Syndrome Undergoing Coronary Artery Intervention

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Abstract

Background: Acute coronary syndrome (ACS), including unstable angina (UA), non-ST elevation myocardial infarction (NSTEMI), and ST elevation myocardial infarction (STEMI), generally results from atherosclerotic plaque rupture or superficial plaque erosion. Despite great progress in the treatment of ACS over the past few decades, ACS is still a major cause of death worldwide**.** The objectives of this study were to study the renal effect of contrast agent injection percutaneous coronary intervention. To detect extractable nuclear antigen (ENA) autoantibodies. To assess brain natriuretic peptide before and after percutaneous intervention. To assess the diagnostic role of brain natriuretie peptide in diagnosis of contrast-induced nephropathy (CIN) after contrast agent injection for percutaneous coronary intervention in patients with acute coronary syndrome.

Methods: This was a cohort study conducted in Cardiology Department in Zagazig University and El-Ahrar Teaching Hospital of Sharkia Governorate on 150 patients. Patients were divided into two groups: I- patients with CIN. II- those with no CIN.

Results: There was statistically non-significant relation between CIN and LVEF<40% or type of ACS. While there was significant relation between CIN and LVEF value (Significantly lower in CIN). There was statistically significant increase among those with CIN than that in Non-CIN regarding serum creatinine and Baseline glucose while there was statistically significant decrease among those with Non-CIN than those with CIN regarding eGFR, mL/min per 1.73 m2. There were statistically significant differences between the studied groups regarding baseline BNP and NT-pro BNP) (both are significantly higher in CIN group); with Sensitivity-Specificity% (73.9-73.7) for BNP, pg/mL. In addition, on doing multivariate regression analysis in this study, NT-Pro BNP>2149 pg/mL sustained significant increase in odds of CIN by 3.444 folds respectively. The present study showed that, the multivessel disease, chronic total occlusion & Syntax score showed significantly higher prevalence among those with CIN than that in Non-CIN. Also The stent diameter was significantly lower in CIN group. There was non-significant relation between CIN and specific artery involvement. There were non-significant differences between CIN and Non-CIN as regard to time of procedure, total amount of contrast, or high contrast volume. Univariate regression analysis of factors between Contrast-Induced Nephropathy and Basic Demographic data (age) is highly significant (p<0.001). However, the Multivariate Analysis showed non significant values (p<0.05). The age significantly increases risk of CIN by 1.08 folds with Univariate Analysis. While on multivariate analysis, it non-significantly increases risk by 1.014 folds.

Conclusion: BNP or NT-proBNP may be an effective predictive marker for CIN. Old age, creatinine, uric acid, and hemoglobin, hs-CRP, LVEF and NT-pro BNP>2149 pg/mL, syntax score, multi vessel disease and chronic total occlusion were predictors of CIN in ACS patients who underwent PCI.

Key words: Brain Natriuretic Peptide -Contrast- Induced Nephropathy –Acute Coronary Syndrome.
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Introduction:

Acute coronary syndrome (ACS), including unstable angina (UA), non-ST elevation myocardial infarction (NSTEMI), and ST elevation myocardial infarction (STEMI), generally results from atherosclerotic plaque rupture or superficial plaque erosion. Despite great progress in the treatment of ACS over the past few decades, ACS is still a major cause of death worldwide [(1).]

For patients with ACS, coronary angiography plays a key role. Early invasive treatment with cardiac catheterization and revascularization remains the preferred treatment for UA and NSTEMI, and timely percutaneous coronary intervention (PCI) for STEMI is recommended as a first-line treatment when prohibitive comorbidities are absent. These treatments can reduce mortality and improve prognosis in patients with ACS [(2).]

Acute kidney injury (AKI) is a common and serious complication of inpatients that causes significant mortality and other severe complications. Patients with ACS, especially those undergoing coronary angiography or PCI, are more likely to develop AKI due to contrast agent exposure. The development of CIAKI after coronary angiography is highly correlated with poor clinical outcomes, such as mortality, adverse cardiac events, and stent restenosis [(3).]

The ability to identify patients at high risk for developing ClAKI identified early is important to allow the treating physician to take necessary precautions to prevent it. Brain natriuretic peptides *response to myocardial ischemia,* are released into the circulation in response to myocardia pressure overload, or ventricular dilatation [(4).]

Previous studies have found elevated concentrations of natriuretic peptide (BNP) or N-terminal pro-B-type natriuretic peptide (NT-proBNP) in patients with ACS and have a prognostic value in patients with ACS. Moreover, some studies have found that levels of BNP or NT-proBNP are higher in patients with AKI, especially for those who are diagnosed with ACS and undergo coronary angiography or PCI [(5).]

The objectives of this study were to study the renal effect of contrast agent injection percutaneous coronary intervention. To detect extractable nuclear antigen (ENA) autoantibodies.To assess brain natriuretic peptide before and after percutaneous intervention.To assess the diagnostic role of brain natriuretie peptide in diagnosis of contrast-induced nephropathy (CIN) after contrast agent injection for percutaneous coronary intervention in patients with acute coronary syndrome.

Patients and Methods

I. Technical design

Setting

Cardiology Department in Zagazig University and El-Ahrar Teaching Hospital of Sharkia Governorate.

Type of study: Cohort study.

Sample Size:

According to Power of test 80% CI confidence level 95%.

Assuming that the total population size of patients with acute coronary syndrome undergoing coronary artery intervention in the study period is (150) patients and the predictive value positive of brain natriuretic peptide as a predictor of contrast-induced nephropathy is (32.3%). So the estimated sample size will be 104 participants by using open EPi program. [(6)]

Inclusion criteria:

- More than 18 middle aged patients with acute coronary syndrome (ACS) to coronary intervention. . An included patients with history of drug intake that affect
- BNP level such as B-blockers, ACES, ARBs& spironolactone are advised to stop these drugs at least 48 hours before the procedure.

Exclusion criteria:

- Patients who are unsuitable for coronary intervention et

decompensated congestive heart failure, hypertensive crises.refractoryarrhythmia,renalimpairement decompensated liver diseases, heamorrhagic blood diseases, thyroid disorders, active infection, marked obesity, pregnancy, contrast medium allergy and advanced malignancy.

II-Operating design:

1- Methods

1) Complete history taking and thourgh clinical examination.
2) ECG
3) Echocardiography.
4) Cardiac enzymes as LDH, SGOT&CPK.
5) Serum cardiac -specific troponin
6) Complete liver function, prothrombin time and PTT.
7) Fasting & Post-prandial blood sugar.
8) Serum creatinine levels were measured at baseline (prior to angiography) and daily postprocedure for at least 3 days.

If the serum creatinine was elevated by >0.3 mg/dL from baseline on either of these first 2 measures, additional daily creatinine levels were measured until renal function was improving.

9) Brain Natriuretic Peptide BNP):

Blood samples for BNP were obtained and measured at the time of admission prior to angiography) in consecutive patients

Measuring brain natriuretic peptide is inexpensive, repeatable, and easy to achieve. For patients with ACS, monitoring brain natriuretic peptide is important and essential.

Patients were divided into two groups:

I- patients with CIN.
II- those with no CIN

III-Administrative Design:

Ethical consideration

Approval from cardiology Department, Faculty of Medicine.Zagazig University.

Approval from Institutional Review Board (IRB).

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean SD, the following tests were used to test differences for significance;.difference and association of qualitative variable by Chi square test (X?). Differences between quantitative multiple by ANOVA or Kruskal Wallis. P value was set at <0.05 for significant results &<0.001 for high significant result.

Data were collected and submitted to statistical analysis. The following statistical tests and parameters were used.

ROC curve

A receiver operating characteristic (ROC), or simply ROC curve, is a graphical plot which illustrates the performance of a binary classifier system as its discrimination threshold is varied. It is created by plotting the fraction of true positives out of the positives (TPR = true positive rate) vs. the fraction of false positives out of the negatives (FPR = false positive rate), at various threshold settings. TPR is also known as sensitivity (also called recall in some fields), and FPR is one minus the specificity or true negative rate.

ROC analysis provides tools to select possibly optimal models and to discard suboptimal ones independently from (and prior to specifying) the cost context or the class distribution. ROC analysis is related in a direct and natural way to cost/benefit analysis of diagnostic decision making. The ROC curve was first developed by electrical engineers and radar engineers during World War II for detecting enemy objects in battlefields and was soon introduced to psychology to account for perceptual detection of stimuli. ROC analysis since then has been used in medicine, radiology, biometrics, and other areas for many decades and is increasingly used in machine learning and data mining research.

Results:

Table (1) Demographic data of the studied patients:

Variable	Non-CIN Group N-88 (84.6%)	CIN Group N-16 (15.4%)	F Value
Age, y^3	60.59 ±12.29	72.22 ± 12.79	<0.001+
Smoking	42 (47.7)	3 (18.8)	0.031+
Male gender (n &%)	63 (71.6)	10 (62.5)	0.464
BMI, kg/m^{25}	27.85 ± 4.5	27.13 & 4.4	0.354

Abbreviations: CIN is contrast-induced nephropathy, Non-CIN is non-contrast- induced nephropathy & BMI is body mass index; *p<0.05 is statistically significant data is represented as meant SD and compared using independent sample t test

Patients with CIN were significantly older than Non-CIN.

The smoking was significantly higher in Non-CIN than CIN

No significant differences between the two groups as regard to the gender & BMI

Non-CIN is significantly associated with smoking and younger age.

Table (2) Baseline data of both past & family history of the studied patients.

Past history of previous renal diseases	25% (22/88)	18.8% (3/16)	0.99
History of CHF	2% (16/88)	7% (1/16)	0.008+
Hypertension, n (%)	40 (45.4)	8(50)	0.737
Diabetes mellitus, n (%)	29 (32.9)	5 (31.3)	0.894
Hyperlipidemia, n (%)	26 (29.5)	3 (18.7)	0.547
Family history of premature CAD.	34% (30/88)	31% (5/16)	0.99
Prior CABG, n (%)	20 (22.7)	3 (18.8)	>0.999

There is statistically non-significant relation between CIN and either gender, BMI, family history of premature CAD, hypertension, diabetes,
hyperlipidemia, or Prior CABG

Past history of previous renal diseases, hypertension, diabetes mellitus, hyperlipidemia, family history of premature CAD &Prior CABG were not significantly associated with higher incidence of CIN.

However, history of CHF was significantly associated with higher incidence of CIN.

Table (3) History of drug intake before admission in both groups of the studied patients:

Variable	Non-CIN Group N-88 (84.6%)	CIN Group N-16 (15.4%)	P value
ACEI or ARB use pre-admission.	23(26.1)	5(31.3)	0.671
Statins use pre-admission.	34(38.6)	6(37.5)	0.931
Diuretics use pre-admission.	22(25.0)	8(50.0)	0.042*

There was statistically non-significant relation between CIN and preadmission use of ACEI/ARB or statins

There was significant relation between CIN and pre-admission use of diuretics (half of those with CIN versus 25% of non-CIN use diuretics)

Table (4) Relation between CIN and both Echo and ECG findings of the studied patients.

Variable	Non-CIN Group N-88 (84.6%)	CIN Group N-16 (15.4%)	P value
LVEF	46 ±8	39.9 ± 9	0.007*
LVEF <40%, %	21(23.9)	5(31.3)	0.53
Type			0.05
STE-ACS	56(63.6)	10(62.5)	
NSTE-ACS	32(36.4)	6(37.5)	

Abbreviations; LVEF: left ventricular ejection fraction, ACS :acute Coronary syndrome, NSTE: non-ST-segment elevation &STE, ST-Segment elevation *p<0.05 is statistically significant.

There was statistically non-significant relation between CIN and LVEF<40% or type of ACS.

There was significant relation between CIN and LVEF value (Significantly lower in CIN).

Table (5) Biochemical laboratory data of the studied patients.

Variable	Non-CIN Group N-88 (84.6%)	CIN Group N-16 (15.4%)	P value
Baseline glucose (median, range)	133.0[119.0 -173.0]	184[131.5 -219.5]	<0.001*
HbA1c, %	6.9 ±1.8	6.7 ±1.7	0.913
ALB, g/L	3.7 ±0.7	3.1± 0.5	<0.001*
Serum creatinine, mg/dL	1.046 ±0.1	1.47 ± 0.3	<0.001*
eGFR, mL/min per 1.73 m2	71.4 ±16.8	48.1± 15.6	<0.001*
Total cholesterol, mg/dL	181 ±39	166 ±451	0.030*
Triglyceride, mg/dL	121 (33-825)	118(45-675)	0.454

Abbreviations; eGFR: estimated glomerular filtration rate&
HbA1c: hemoglobin A1c:
There were statistically significant difference between the studied groups regarding baseline glucose, serum albumin, serum creatinine, eGFR, and total cholesterol (glucose, serum creatinine are higher in CIN group while albumin, total cholesterol, eGFR are significantly lower in CIN group)
There were statistically non-significant difference between groups regarding HbA1c or serum triglycerides.

Table (6) Cardiac Biomarkers of the studied patients in both groups.

Variable	Non-CIN Group	CIN Group	P value

(Mean & Range)	N-88 (84.6%)	N-16 (15.4%)	
Peak CK-MB, ng/mL	33.6(0.68 -425)	54.4(3.2 -416)	0.31
hs-CRP, mg/L	7.5 3.7	8.4 3.6	0.014*
NT-pro BNP, pg/mL	754 (177.4-2164)	5979(2282-9677)	<0.001*
BNP, pg/mL	284(61-858)	695(88-3,800)	0.001
Peak Troponin T, ng/mL	1057(934-1294)	1783(1466-18960)	0.025

Abbreviations; CK-MB,:creatine kinase-myocardial band, hs-CRP, :high-sensitivity C-reactive protein & NT-pro BNP :N-terminal pro-brain natriuretic peptide.

There were statistically significant differences between the studied groups regarding baseline hs CRP and NT-pro BNP) (both are significantly higher in CIN group)

There was statistically non-significant difference between groups regarding peak CK-MB.

Table (7): Shows BNP, pg/mL means and ranges.

Variable	No-CIN Group N-88 /84.6%	CIN Group N-16 /15.4%	P value	Sensitivity-Specificity%
BNP, pg/mL	284(61-858)	695(88-3,800)	<0.001	73.9-73.7

Table (8) Angiographic Procedural Characteristics in Patients of both group.

Variable	Non-CIN Group N-88 (84.6%)	CIN Group N-16 (15.4%)	P value
Total time of procedure, min	35.4±16.5	38.98±15	0.152
Total amount of contrast, mL	163 ± 62	170±73	0.270
High-contrast volume	54(61.3)	10(62.5)	0.823

There were non-significant differences between CIN and Non-CIN as regard to time of procedure, total amount of contrast, or high contrast volume.

Table (9) Characteristics of vascular occlusion pattern in Patients of both groups.

Variable	Non-CIN Group N-88 (84.6%)	CIN Group N-16 (15.4%)	P value

Multivessel disease, n (%)	54(54.5)	12 (75)	0.005*
Chronic total occlusion, n (%)	15(17.4)	5 (31.2)	0.006*
Syntax score	15.29 8.29	21.49 10.69	<0.001*
Culprit vessel, n (%)			
Left main coronary artery	3 (0.3)	0 (0)	0.457
Left anterior descending artery	43 (48.9)	8 (50)	0.933
Left circumflex artery	18 (20.5)	3 (18.7)	>0.999
Right coronary artery	28 (31.8)	5 (31.3)	0.964

The multivessel disease, chronic total occlusion & Syntax score showed significantly higher prevalence among those with CIN than that in Non-CIN.

There was non-significant relation between CIN and specific artery involvement.

Table (10): Characters of graft & stent in Patients of both groups.

Variable	**Non-CIN Group N-88 (84.6%)**	**CIN Group N-16 (15.4%)**	**P value**
Saphenous vein graft	3 (2.5)	3 (0.5)	>0.999
Stent implantation, n (%)	82 (93.1)	14 (87.5)	0.606
Total length of stent ,mm	25 ±12	26.17 ±11	0.479
Stent diameter, mm	3.14 ± 0.33	3.02±0.25	0.037*

The stent diameter was significantly lower in CIN group.
There were non-significant differences between CIN and Non-CIN
Patients as regard to saphenous vein graft, no. of stent implantation or total length of stent.

Table (11) Logistic Regression Analysis of the Association Between Contrast-Induced Nephropathy and Basic Demographic data.

Variable	**Univar ate Analysis**		**Multivariate analysis**	
	Odds Ratio (95% CI)	**P value**	**Odds Ratio (95% CI)**	**P value**
Age	1.08 (1.050-1.104)	<0.001*	1.014(0.981 -1.054)	0.323
Smoking	0.21 (0.103-0.425)	<0.001*	0.471(0.16 -1.331)	0.155

Univariate regression analysis of factors between Contrast-Induced Nephropathy and Basic Demographic data (age &smoking) is highly significant (p<0.001). However, the Multivariate Analysis showed non-significant values(p<0.05).

The age significantly increase risk of CIN by 1.08 folds with Univariate Analysis .While on multivariate analysis, it non-significantly increases risk by 1.014 folds

Smoking significantly protects against CIN in univariate and still protective factors on doing multivariate analysis yet with non-significant difference.

Table (12) Logistic Regression Analysis of the Association Between Contrast-Induced Nephropathy and biochemical biomarkers.

Variable	Univar ate Analysis		Multivariate analysis	
	Odds Ratio (95% CI)	P value	Odds Ratio (95% CI)	P value
Hemoglobin	0.701(1.050-1.104)	<0.001*	0.914(0.759 -1.093)	0.321
Creatinine	14.011(6.071-32.361)	<0.001*	6.054(1.860-19.684)	0.003
Uric acid	1.457(1.235-1.706)	<0.001*	1.123(0.895-1.412)	0.312
Total cholesterol	0.993 (0.987-0.999)	<0.001*	1.016(0.992 -1.043)	0.130

Univariate regression analysis of factors showed significant relation between the levels of serum creatinine, uric acid, and hemoglobin & the risk of CIN(by 0.70, 14.01, and 1.457, 1folds respectively).

They were significant protective factors in univariate analysis while there are still protective in multivariate analysis but without significant relation (p>0.05) except serum creatinine which showed sustained significant increase in odds of CIN by 6.054 folds.

Table (13) Logistic Regression Analysis of the Association Between Contrast-Induced Nephropathy and Nephropathy and cardiac parameters.

Variable	Univariate Analysis		Multivariate analysis	
	Odds Ratio (95% CI)	P value	Odds Ratio (95% CI)	P value
NT-pro BNP, pg/mL	11.110(5.781-21.272)	<0.001*	3.444(1.094-8.476)	0.008*
LVEF	0.941(0.913-0.968)	<0.001*	0.974(0.934-1.015)	0.176
hs-CRP	1.1024(1.013-1.192)	<0.001*	0.932(0.833-1.047)	0.235

On doing univariate regression analysis of factors significantly associated with hs-CRP, LVEF and NT-pro BNP>2149 pg/mL. Increasing LVEF were protective factors (p<0.05).

However on doing multivariate regression analysis, only NT-Pro BNP>2149 pg/mL sustained significant increase in odds of CIN by 3.444 folds respectively.

Table (14) Logistic Regression Analysis of the Association Between Contrast-Induced Nephropathy and Nephropathy and cardiovascular Parameters.

Variable	Univariate Analysis		Multivariate analysis	
	Odds Ratio (95% CI)	P value	Odds Ratio (95% CI)	P value
Syntax score	1.079(1.045-1.118)	<0.001*	1.030 (0.981 – 1.086)	0.233
Multi vessel disease	2.568 (1.928-4.799)	0.003*	0.668(0.269-1.643)	0.377
Chronic total occlusion	2.207(1.217-3.996)	0.008*	1.254 (0.504-3.103)	0.62

On doing univariate regression analysis of factors significantly associated with CIN; syntax score, multi vessel disease and chronic total occlusion significantly increase risk of CIN by 1.079, 2.568 and 2.207 folds respectively

However, neither of these parameters yields significant effect on doing multivariate analysis.

Discussion

According to CIN incidence in our study; the studied patients were categorized into two groups. No-CIN group included 88 patients (84.6%) and CIN group (16.4%).

The study by **Mehran et al.** [7] in which the overall incidence of CIN development was 13.1%. But it was different from the study of **Maioli et al.** [8]in which the percentage of CIN development was 27.3%.

Our results revealed that, there was statistically non-significant relation between CIN and preadmission use of ACEI/ARB or statins. There was significant relation between CIN and pre-admission use of diuretics (half of those with CIN versus 25% of non-CIN use diuretics)

According to**Gu et al.** [9] who showed that the use of ACEIs/ARBs was associated with an increased incidence of CI-AKI following exposure to the second contrast agent. Diuretic ($P = 0.006$) was strongly associated with the development of CI-AKI following administration of the first contrast agent.

Duan et al. [10] proposed that ACEIs can prevent CI-AKI. Nonetheless, opposing results have been published over the past few years. For example, **Kiski et al.** [11] found that patients taking ACEIs/ARBs developed CI-AKI significantly more often within 72 h after contrast media administration.

Our study showed that, there was statistically non-significant relation between CIN and LVEF<40% or type of ACS. While there was significant relation between CIN and LVEF value (Significantly lower in CIN).

Elevated BNP levels in STEMI are known to be associated with reduced LVEF with or without systemic hypotension and with the presence of clinical signs of cardiac decompensation (Killip Classes >I). Thus, admission BNP could be regarded as an objective measure of ventricular performance before coronary angiography thereby improving early estimation of risk of CI-AKI [12].

The risk of CI-AKI associated with higher BNP concentrations was independent of LVEF and congestive heart failure suggesting that additional pathophysiological processes might have significant role linking BNP concentrations with worsening renal function after primary PCI [13].

Our results are in disagreement withMontaser**Hamdy et al.** [14] who reported statistically significant relation was found between CIN and ACS type (NSTEMI)

This study showed that, there was statistically significant increase among those with CIN than that in Non-CIN regarding serum creatinine and Baseline glucose while there was statistically significant decrease among those with Non-CIN than those with CIN regarding eGFR, mL/min per 1.73 m2.

This agrees with **Li et al.** [15] who reported that, the diagnosis of CI-AKI is based on the increased serum creatinine concentration after a contrast agent injection. However, changes in serum creatinine lack sensitivity because in healthy people, nearly 50% of the glomerular filtration rate (GFR) must be lost before changes in serum creatinine can be detected [16]. Moreover, there are no consistent thresholds of serum creatinine levels for the diagnosis of CI-AKI [17].

The current study showed that, there were statistically significant differences between the studied groups regarding baseline BNP and NT-pro BNP) (both are significantly higher in CIN group); with Sensitivity-Specificity% (73.9-73.7) for BNP, pg/mL.

In addition, on doing multivariate regression analysis in this study, NT-Pro BNP>2149 pg/mL sustained significant increase in odds of CIN by 3.444 folds respectively.

This is in harmony with **Li et al.** [2] who reported that, the results suggested that BNP or NT-proBNP is a useful biomarker for the diagnosis of CI-AKI (AUC = 0.81, SEN = 0.73, and SPE = 0.79). The finding applies to both BNP (AUC = 0.78, SEN = 0.69, and SPE = 0.80) and NT-proBNP (AUC = 0.82, SEN = 0.77, and SPE = 0.78).

Moreover, **Jarai et al** [13] demonstrated a relationship between (BNP) level on admission and development of CIN after primary PCI in STE-ACS patients.

Jarai et al., [13] have demonstrated that elevated BNP levels are also an independent predictor of CI-AKI, which itself portends an adverse prognosis in STEMI [17].

Our results are in accordance with previous observation of a study showing that patients with acute heart failure who develop acute kidney

injury within 48 hours after admission have significantly higher initial BNP concentrations [18].
Furthermore, a recent study established a firm relationship between preoperative BNP concentrations and the risk of kidney injury after cardiac surgery [19].
Study of **Liu et al.** [20] showed that the best cut-off NTproBNP value for detecting CIN was 1800 pg/mL with 69% sensitivity and 70.0% specificity.
Yeliz et al. [21] reported that, NT-proBNP elevation or low LVEF were evaluated as cardiac dysfunction. According to their study; there was statistically significant relationship between cardiac dysfunction and CI-AKI.
The N-terminal portion of pro-BNP appears more stable than BNP and is used as a marker instead of BNP [22].
The present study showed that, the multivessel disease, chronic total occlusion & Syntax score showed significantly higher prevalence among those with CIN than that in Non-CIN.
Also our study showed that, the stent diameter was significantly lower in CIN group.
This is similar with previous studies that have indicated that CI-AKI is associated with adverse clinical outcomes, including prolonged hospitalization, an increased risk of mortality, stent restenosis, and cardiovascular and cerebrovascular events in patients with ACS undergoing coronary angiography [23; 24].
This also in accordance with**Kurtul et al.** [25] who reported that, multivessel disease (MVD), high SYNTAX scores, and low stent diameters were associated with a higher incidence of CIN.
This study showed that, there was non-significant relation between CIN and specific artery involvement.
In contrast, Left main coronary artery lesions, have been reported to be strong risk factors for CI-AKI in previous studies [26].
In this study, there were non-significant differences between CIN and Non-CIN as regard to time of procedure, total amount of contrast, or high contrast volume.
Kurtul et al. [25] reported that, it appears (although not statistically significant) that procedural success was considerably lower in the CIN group as compared to the no-CIN group. They think it may be due to the amount of contrast agent and total time of the procedure in the CIN group compared to the no-CIN group (although not statistically significant).
Univariate regression analysis of factors between Contrast-Induced Nephropathy and Basic Demographic data (age) is highly significant ($p<0.001$). However, the Multivariate Analysis showed non significant values ($p<0.05$). The age significantly increases risk of CIN by 1.08 folds with Univariate Analysis. While on multivariate analysis, it non-significantly increases risk by 1.014 folds.
Abdel-Ghany et al. [27] reported that, the risk factors of significance in CIN development were determined using logistic regression analysis. In group II, age was significantly higher than in group I. It was considered as an independent predictor of CIN development and similar to that reported by **Li et al.** [28] who noticed that CIN development was associated with old age. The higher incidence of CIN in old age was explained by the age-related changes in kidney function such as decreased GFR, tubular secretion, and impaired concentrating ability. Co-morbid diseases such as HTN that affect kidney function may be an additional factor for CIN in the elderly [29].
Age was found to be an important risk factor for CI-AKI [30; 31].

Conclusion:
Our findings suggest that BNP or NT-proBNP may be an effective predictive marker for CIN. Old age, creatinine, uric acid, and hemoglobin, hs-CRP, LVEF and NT-pro BNP>2149 pg/mL, syntax score, multi vessel disease and chronic total occlusion were predictors of CIN in ACS patients who underwent PCI.

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