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The relation between vascular access and development of contrast induced nephropathy in patients undergoing percutaneous coronary intervention

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Abstract
Background: Contrast induced nephropathy (CIN) could be a serious outcome complicating percutaneous coronary intervention (PCI) patients affecting both morbidity and mortality. The aim of this work was to study the relation between vascular access and development of contrast induced nephropathy in patients undergoing PCI.
Methods: This prospective study was carried out on 300 patients aged above 18 years old undergoing PCI. Patients were divided in to two equal groups: Group I: underwent trans-femoral PCI. Group II: underwent trans-radial PCI.
Results: There was no significant difference in minimizing the risk of CIN between the two comparable approaches. In multivariate logistic regression analysis, the volume of contrast used was a significant parameter increasing the incidence of CIN [P value 0.025, OR (95% C.I) 1.020 (1.002-1.037)]. Also, patient's left ventricle ejection fraction after PCI was found to be significant parameter affecting the incidence of CIN [P value 0.028, OR (95% C.I) 0.919(0.852-0.991)].
Conclusions: Radial access for PCI isn't inferior to femoral access as regards risk of CIN in patients undergoing PCI.

Keywords: Contrast induced nephropathy, percutaneous coronary intervention, vascular access, femoral, radial

Introduction
Intravenous iodinated contrast chemicals are often used in radiology procedures for both curative and diagnostic objectives. As a consequence, procedure-related, contrast-induced nephropathy (CIN) is becoming more common [1].
The usual definition of CIN is a short-term deterioration in the functioning of the kidneys following the introduction of iodinated contrast substances. More than 25% rise in serum creatinine (Scr) or a rise of 0.5 mg/dL from pre-treatment levels within 24-48 hours after injection are two examples of laboratory tests that indicate CIN [1].
Over 10% of acute renal damage instances in hospitalized individuals are due to CIN, a serious clinical issue [2].
A number of risk elements have been shown to be accurate indicators of CIN [3].
There is mixed evidence regarding access to the vessels as a risk factor for CIN in individuals having coronary angiography [4].
The significance of access site selection as a decision-making tool to reduce the risk of impaired renal function among individuals with coronary artery disease having angiography either alongside or without percutaneous coronary intervention (PCI) is becoming more recognised [5].
When done by a skilled radial operator, radial access is preferred over femoral approach for coronary angiography [6].
Interventional cardiologists are increasingly using trans-radial access for PCI or angiography [7].
Comparison between CIN incidence with radial and femoral access may help to guide cardiologists to future ideal vascular access.

This work aimed to evaluate the relation among vascular access and development of CIN among individuals receiving PCI.

Patients and Methods

This prospective work was performed on 300 individuals aged above 18 years old undergoing PCI. The study was done between March 2022 to October 2022 following Tanta University Hospitals' Ethical Committee has given its clearance. Participants provided signed permission after being fully briefed.

Criteria for exclusion were individuals who were hemodynamically unstable, those in shock or Killip class IV, who had pre-existing chronic kidney disease (CKD) (those with serum-creatinine level ≥1.5mg/dl) or end-stage renal disease, diseases of the immune system or haematological conditions that influence the coagulation profile and who have received more than 250 ml of contrast.

Participants had been allocated in to two equal groups: group I: receive trans-femoral PCI and group II: receive trans-radial PCI.

Each participant were exposed to taking of history, history of risk factors for CIN [Diabetes Mellitus, hypertension, smoking, previous ischemic cardiomyopathy and nephrotoxic drug intake], and clinical examination.

The assessment of severity of heart failure was done using Killip score. The standard 12-lead ECG was done for all participants. Also, right pericardial leads and posterior chest leads were performed for some participants to identify posterior wall and right ventricular infarction.

Creatinine level before and 48 h after PCI, RBG was tested once patients admitted to CCU.

Echocardiography: The (GE-vivid seven cardiac ultrasound system) was used for all experiments.

Two- Dimensional echocardiographic assessment by M-mode and modified Simpson method were done during admission after successful PCI. 2-D Echocardiography was done in partial left lateral decubitus position: M-mode assessment of LV systolic function through getting the long parasternal axis view and directing the M-mode cursor among the LV & it is measured also in the parasternal short view with directing the M-mode cursor among the mid LV. The M-mode echocardiography measures the left ventricular endsystolic diameters, left ventricular enddiastolic diameters, thickness of inter-ventricular septum and thickness of posterior wall. Assess segmental wall motion abnormalities and global wall motion. assessment of mitral regurgitation depending on color flow regurgitation jet, density of continuous wave regurgitation jet, and vena contracta width [8].

PCI: Coronary angiography had been conducted utilizing local anaesthesia. The patient lied down in supine position, at the location of arterial puncture, an optimal femoral or radial pulse had to be palpated in order to locate the artery. A local anesthesia was applied. The puncture of the femoral artery was performed some 2 cm below the inguinal ligament. All patients were subjected to PCI using the same "iohexol" contrast.

All individuals with acute coronary syndrome were given aspirin (150-300 mg loading dose), clopidogrel (600 mg loading dose), or ticagrelor (180 mg loading dose), along with an un-fractionated heparin bolus of 70-100 U/kg intravenous if no GPIIb/IIIa inhibitors had been scheduled and 50-60 U/kg intravenous bolus with GP IIb/IIIa inhibitors prior to the procedure.

proficient interventional cardiologists examined and interpreted angiographic films with respect to TIMI flow prior to and following revascularization, no-slow reflow, contrast-volume, fluoroscopy duration, stenting, DES use, thrombus-aspiration, and, if the operator preferred, the administration of GPIIB/IIIA receptor inhibitors.

Statistical analysis

SPSS v20 (Armonk, NY: IBM Corp) was used for statistical analysis. Numbers and percentages were used to express the qualitative data. Utilizing the Shapiro-Wilk test, the distribution's normality was confirmed. The range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR) were used to characterize quantitative data. The significance of the obtained results was judged at the 5% level.

Results

No statistically substantial variation was existed among studied groups as regard sex, age, smoking, diabetes mellitus, hypertension, ischemic cardiomyopathy, and nephrotoxic drugs as a risk factors. Table 1.

Table 1: Comparison between the two studied groups according to demographic data smoking, DM, hypertension, previous ischemic cardiomyopathy, and Nephrotoxic drug intake

		Group I (n = 150)	Group II (n = 150)	Test of Sig.	p
Sex	Male	103 (68.7%)	107(71.3%)	χ^2= 0.254	0.614
	Female	47(31.3%)	43(28.7%)		
Age (years)		56.90 ± 11.07	55.01 ± 11.35	t= 1.463	0.145
Risk factors	Smoking	88 (58.7%)	91 (60.7%)	χ^2=0.125	0.724
	Diabetes	68 (45.3%)	72 (48.0%)	χ^2=0.214	0.643
	Hypertension	80 (53.3%)	66 (44.0%)	χ^2=2.615	0.106
Previous ischemic cardiomyopathy		5 (3.3%)	5 (3.3%)		
Nephrotoxic drug intake		37 (24.7%)	32 (21.3%)	χ^2=0.471	0.493

Data are presented as mean ± SD or frequency (%).

No statistically substantial variation was existed among the groups under the study as regard systolic blood pressure, diastolic blood pressure, random blood sugar (RBS) at admission. Table 2.

Table 2: Comparison between the two studied groups according to blood pressure and RBS on admission

	Group I (n = 150)	Group II (n = 150)	U	p
RBS on admission (mg/dL)	187.7 ± 52.60	187.7 ± 54.18	11198.0	0.945
SBP on admission (mmHg)	128.7 ± 21.07	126.7 ± 19.05	10868.0	0.606
DBP on admission (mmHg)	77.03 ± 10.33	76.57 ± 9.88	11058.0	0.788

Data are presented as mean ± SD. RBS: random blood sugar, SBP: systolic blood pressure, DBP: diastolic blood pressure.

No statistically substantial variation was existed among the two groups as regard acute coronary syndrome type as a risk factor. Table 3.

Table 3: Comparison between the two studied groups according to acute coronary syndrome type

ECG	Femoral (n = 75)	Radial (n = 87)	χ^2	p
STEMI	17 (22.7%)	16 (18.4%)	0.454	0.500
NSTE-ACS	58 (77.3%)	71 (81.6%)		

Data are presented as frequency (%). STEMI: non-ST-segment elevation myocardial infarction, NSTE-ACS: Non-ST Elevation-Acute Coronary Syndrome

No statistically substantial variation was existed among the groups under the study regarding PCI type, number of stents used, volume of contrast used, TIMI flow after PCI, LV ejection fraction after PCI, serum creatinine level after PCI. Table 4.

Table 4: Comparison between the two studied groups according to PCI type, number of stents used, volume of contrast used, TIMI flow after PCI, LV ejection fraction after PCI

		Group I (n = 150)	Group II (n = 150)	Test	p
PCI type	Primary	75 (50.0%)	87 (58.0%)	χ^2=1.932	0.164
	Elective	75 (50.00%)	63 (42.0%)		
Number of stents	1	72 (48.0%)	73 (48.7%)	χ^2=0.222	0.895
	2	51 (34.0%)	53 (35.3%)		
	3	27 (18.0%)	24 (16.0%)		
Volume of contrast used		155.80±49.81	159.17±51.85	U=10956.0	0.683
TIMI after PCI	I	2 (1.3%)	2 (1.3%)	χ^2=0.248	1.000
	II	2 (1.3%)	2 (1.3%)		
	III	146 (97.3%)	146 (97.3%)		
LV ejection fraction		48.37±10.03	48.71±10.38	U=10933.5	0.673

Data are presented as mean ± SD or frequency (%). PCI: percutaneous coronary intervention

No statistically substantial variation was existed among studied groups as regard occurrence of CIN, need for fluids or dialysis in CIN patients. Table 5.

Table 5: Distribution of the studied cases according to serum creatinine level after PCI, occurrence of CIN, Comparison between the two studied groups according to need to fluids or dialysis in CIN patients

		Group I (n = 150)	Group II (n = 150)	χ^2	^{FE}p
Serum Creatinine (mg/dL)	Before	1.0 ± 0.18 (0.50 – 1.40)	1.01 ± 0.18 (1.01 ± 0.18)	10920.5	0.652
	After	0.96 ± 0.25 (0.60 – 2.50)	0.94 ± 0.23 (0.60 – 2.30)	10721.50	0.472
	Z (p_0)	3.637* (<0.001*)	5.348* (<0.001*)		
Occurrence of CIN	No CIN	145 (96.7%)	146 (97.3%)	0.115	1.000
	Occurrence of CIN	5 (3.3%)	4 (2.7%)		
Need to fluids or dialysis in CIN patients	Fluids	4 (2.7%)	3 (2.0%)	-	-
	Dialysis	1 (0.7%)	1 (0.7%)	-	-

Data are presented as mean ± SD (Range) and frequency (%), CIN: contrast-induced nephropathy.

It was found from Univariate logistic regression analysis of the data that the incidence of CIN increased significantly with age [P value 0.018, OR (95% C.I) 1.082(1.014-1.155)].

Presence of diabetes mellitus also significantly increased the occurrence of CIN [P value 0.034, OR (95% C.I) 9.576(1.182-77.548)]. Also, the volume of contrast used was found to be a significant parameter increasing the incidence of CIN [P value 0.003, OR (95% C.I) 1.024 (1.008-1.041)]. Lastly Patient's LV ejection fraction after PCI was also found to be significant parameter affecting the incidence of CIN [P value 0.016, OR (95% C.I) 0.921(0.860 - 0.985)].

Regarding multivariate logistic regression analysis of parameters affecting CIN it was found that the volume of contrast used was a significant parameter increasing the incidence of CIN [P value 0.025, OR (95% C.I) 1.020(1.002-1.037)]. Also, Patient's LV ejection fraction after PCI was found to be significant parameter affecting the incidence of CIN [P value 0.028, OR (95% C.I) 0.919(0.852-0.991)]. Table 6.

Table 6: Univariate and multivariate Logistic regression analysis for the parameters affecting CIN

	Univariate		#Multivariate	
	p	OR (LL – UL 95%C. I)	p	OR (LL – UL 95%C.I)
Gender (female)	0.825	1.172(0.287 – 4.795)		
Age (years)	0.018*	1.082(1.014 – 1.155)	0.071	1.064(0.995 – 1.139)
Smoking	0.352	0.530(0.139 – 2.016)		
Diabetes	0.034*	9.576(1.182 – 77.548)	0.089	6.611(0.750 – 58.253)
Hypertension	0.676	1.330(0.350 – 5.052)		
RBS at admission	0.574	1.003(0.992 – 1.015)		
SBP at admission	0.128	1.023(0.993 – 1.054)		
DBP at admission	0.196	1.041(0.979 – 1.108)		
Previous ischemic cardiomyopathy	0.076	8.812(0.795 – 97.738)		
Nephrotoxic drug intake	0.459	1.705(0.415 – 7.001)		
LV ejection fraction	0.016*	0.921(0.860 – 0.985)	0.028*	0.919(0.852 – 0.991)
Creatinine before	0.170	12.373(0.34 – 449.14)		
PCI type	0.066	0.141(0.017 – 1.138)		
Volume of contrast used	0.003*	1.024(1.008 – 1.041)	0.025*	1.020(1.002 – 1.037)
Number of stents	0.209	1.718(0.738 – 3.996)		
TIMI after PCI	0.999	–		
STEMI	0.056	0.212(0.043 – 1.039)		
Vascular access (Femoral)	0.736	1.259(0.331 – 4.781)		

STEMI: non–ST-segment elevation myocardial infarction, PCI: percutaneous coronary intervention

Discussion

A significant clinical issue that causes over 10% of hospitalized patients' acute kidney damage instances is contrast-induced nephropathy (CIN) [9].

In our study, no statistically substantial variation was existed among both groups as regard age and sex.

This came in line with a work conducted by Kanic. *et al* [4], but it came contrasted to the work conducted by Samy N. *et al*. [10]

In the current study, no statistically substantial variation was existed among the two groups as regarding DM, hypertension, smoking, preexisting cardiomyopathy and nephrotoxic drug intake. This came in line with the study conducted by Kanic V. *et al*. [4] on 3842 patients myocardial infarction patients undergoing PCI of which 35.8% were performed radially.

On hospital admission, the clinical presentation of the studied patients was variable:

Our study included patients admitted for both elective and primary PCI. Of those, 75 patients (50%) of the femoral group and 87 patients (58%) of the radial group were admitted for elective PCI while the remainder presented by acute coronary syndrome and admitted for primary PCI.

On the contrary, the work conducted by Samy N. *et al*. [10] involved 60 patients eligible for invasive treatment of acute coronary syndrome (ACS) without involvement of elective PCI cases nor diagnostic coronary angiography cases.

Also, in the study conducted by Kanic V. *et al*. [4] only primary PCI cases were included.

Most of our primary PCI cases were NSTE-ACS patients who constituted 77.3% of the femoral group and 81.6% of the radial group confirming absence of significant difference between both groups as regard clinical presentation. This was in contrast to the work performed by Samy N. *et al*. [10] in which most of the patients were STEMI patients.

As regards hemodynamics at presentation, systolic and diastolic blood pressures of patients on admission revealed no statistically substantial variation among both groups.

This came in line with the meta-analysis conducted by Wang C. *et al*. [7] as no variation was existed among the two groups as regard hemodynamics at presentation.

As regards left ventricular ejection-fraction following PCI, no substantial variation was existed among the two groups. Similarly, in the study conducted by Samy N. *et al* [10] no substantial variation was existed among both groups as regard LVEF after PCI with a p value of 0.15

In our study, volume of contrast used, number of stents used, TIMI flow following PCI in the two groups revealed no substantial variation was existed among the two groups. Similarly, the study conducted by Feldkamp T. *et al*. [2] where volume of contrast ranged showed no substantial variation was existed among the two groups. Also, in the work conducted by Samy N. *et al*. [10] no substantial variation was existed among femoral and radial groups as regard number of stents. In concordant to our study, In Samy N. *et al*. [10] in their study, 83.3% of both femoral and radial groups had TIMI III flow after PCI, 16.7% of both groups had TIMI II flow after PCI and none had TIMI 0 or I after PCI.

In our work, no statistically substantial variation was existed among both groups regarding RBS at presentation and pre-PCI serum creatinine level.

This came in contrast to the work conducted by Kanic. *et al*. [4] which revealed that a statistically significant substantial variation was existed among the therapy regarding pre-PCI serum creatinine level. This also came in contrast to the work performed by Feldkamp T. *et al*. [2] in which a statistically substantial variation was existed among femoral group and radial group as regard pre-PCI serum creatinine level. This is most probably due to their larger sample size.

Our work didn't demonstrate substantial variation of occurrence of CIN among femoral access vs radial access. CIN occurred in (3.3%) of individuals with femoral approach in opposition to (2.7%) with radial approach. This also came in agreement with a work performed by Kolte D. *et al*. [11] that shows no statistically substantial variation among femoral and radial access.

This came in line with a work conducted by Samy N. *et al*. [10] which didn't reveal substantial variation of occurrence of CIN between femoral access vs radial access.

Conversely, individuals receiving heart catheterization with radial artery approach had a much lower risk of AKI (10.1%) in research by Feldkamp T. *et al*. [2] than

individuals receiving heart catheterization by femoral approach.

It was found from univariate logistic regression analysis of the data that increased age significantly increased the incidence of CIN. In concordant to our study, In Kurtul A. *et al*. [12], showed that patients who developed CIN tend to be older.

Similarly, In Inohara T. *et al*. [13] revealed that individuals who developed CIN tend to be older.

The presence of diabetes mellitus also significantly affected the occurrence of CIN.

In concordant to our work, in Kurtul A. *et al*. [12], their study revealed that (47.2%) of patients who developed CIN following PCI were diabetics. According to our research, Evola S. *et al*. [14] Compared to individuals who did not get AKI, 42% of the 105 individuals who obtained CIN were determined to be diabetic, with a P. value of 0.03.

Additionally, it was shown that a key determinant raising the probability of CIN was the amount of contrast utilized. According to a multi-variate logistic regression model, there is a link among contrast volume and the development of CIN following primary PCI, which is consistent with the findings of our research by Mehran *et al*. [15]. Conversely, Andà G. *et al*. [5] showed that total contrast volume didn't vary in volume throughout PPCI among participants with and without AKI, indicating that it isn't an independent risk factor for CIN. The conflicted results may be due to the larger sample size as it was a systemetic review performed on 13 studies and the different study design.

Lastly Patient's LV ejection fraction after PCI was also found to be significant parameter affecting the incidence of CIN. In concordant to our study, in Chou *et al*. [16], their study also demonstrated that the congestive heart failure is a strong independent risk predictor for CIN. In a multivariate logistic regression model.

It was also found from multivariate logistic regression analysis of the data that the volume of contrast used and Patient's LV ejection fraction after PCI significant parameter increasing the incidence of CIN. According to Mehran *et al*. [15], there is a link among contrast volume and the development of CIN following primary PCI, as shown by a multi-variate logistic regression model. This finding is consistent with our research. On the other hand, Andò G. *et al*. [5], their study demonstrated that total contrast volume is not in-dependent indicator for risk for CIN its volume throughout PPCI didn't varu among individuals with or without AKI. Also, Patient's LV ejection fraction after PCI was found to be significant parameter affecting the incidence of CIN. In concordant to our study, Congestive heart failure has been shown to be a potent independent risk factor for CIN by Chou *et al*. [16]. In a model composed of multivariate logistic regressions.

Limitations: The sample size was relatively small. The work was in a single-center. Also, periprocedural bleeding and anemia weren't studied in our study as CIN risk factors. A longer duration of serum creatinine level follow up may help to detect if CIN is underdiagnosed.

Conclusions

Radial access for PCI isn't inferior to femoral access as regard risk of CIN.

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Conflict of Interest: Nil

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