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Correlation between Contrast Medium Amount and the Estimated Glomerular Filtration Rate before and after Percutaneous Coronary Intervention in Diabetic and Non-Diabetic Patients

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ORIGINAL ARTICLE

Correlation between Contrast Medium Amount and the Estimated Glomerular Filtration Rate before and after Percutaneous Coronary Intervention in Diabetic and Non-Diabetic Patients

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Abstract

Background: ***Iodinated contrast material injections may lead to a serious angiography complication known as contrast-induced nephropathy (CIN).***

Objectives: ***This study aimed to compare the contrast medium volume (CMV) to the estimated glomerular filtration rate (eGFR) in patients undergoing percutaneous coronary intervention who have diabetes and those who do not.***

Methods: ***This Prospective Cohort research included 200 individuals, regardless of sex, over the age of 18, who underwent elective or emergent percutaneous coronary intervention (PCI). Subjects were separated into two equal groups: Group "I" had 100 diabetic individuals.***

Group "II" included 100 patients without diabetes.

Results: ***Diabetics had a considerably higher CMV/eGFR ratio than non-diabetics, and positive CIN was greater than negative CIN. At a cut-off of >1.3, the CMV/eGFR ratio can strongly predict CIN, with 35% of diabetic patients developing CIN and only 15% of non-diabetics developing CIN.***

Conclusion: ***The CMV/eGFR ratio can indicate CIN in diabetic and non-diabetic patients after PCI, and it is considerably greater in diabetic than non-diabetic groups. Because it shows the quantity of contrast medium and renal function, two major risk factors for CIN development, it has predictive value.***

Keywords: Contrast Medium; Glomerular Filtration Rate; Percutaneous Coronary Intervention; Diabetes Mellitus; Contrast medium volume/estimated glomerular filtration rate Ratio

1. Introduction

Coronary artery disease (CAD) is a global health burden and is responsible for causing 20 million deaths in 2020. Daily, thousands of people with myocardial ischemia and infarction are admitted to healthcare facilities, and these patients undergo various diagnostic approaches to identify the pathogenesis and severity of the disease. [1]

Iodinated contrast material injections may lead to a serious angiography complication known as contrast-induced nephropathy (CIN).[2] CIN accounts for around 12% of instances of hospital-acquired acute renal injury, making it the third major cause. Conditional incidence rates of CIN vary from 0% to 24% among patients with certain risk factors .[3] Numerous variables have been shown to increase the likelihood of CIN .[4] The most significant risk factor for contrast-induced nausea and vomiting CIN is preexisting renal impairment; however, the quantity of contrast media utilized is also a risk factor .[5] It is predicted that radiocontrast treatment, which is similarly associated with hypoxic and oxidative stress, may exacerbate renal hypoxic and oxidative stress in diabetic kidneys .[5] To determine the maximum radiographic contrast dose (MRCD), or maximum radiographic contrast dosage, use the following formula: the ratio of 5 milliliters of contrast medium per kilogram of body weight (up to 300 milliliters) to millimg/dL of serum creatinine .[6]

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An investigation by Freeman et al.[7] has shown that dosing within the MRCD reduced the occurrence of CIN. This means that CIN may develop in relation to either the quantity of contrast media given or the severity of renal insufficiency. We think that the CMV/eGFR ratio would be a better predictor than the dosage of contrast medium or kidney function only and to test its association with diabetes. This study aimed to compare the contrast medium volume (CMV) to the estimated glomerular filtration rate (eGFR) in patients undergoing percutaneous coronary intervention who have diabetes and those who do not.

2. Patients and methods

This Prospective Cohort research included 200 individuals, split evenly between males and females, were the subjects of the current prospective cohort study: Within Group "I," 100 people with diabetes are included. 100 healthy people undergoing elective or emergency percutaneous coronary intervention (PCI) made up Group "II." Not all these people had diabetes.

Diabetes mellitus (DM) history was identified as having DM if the individual had a history of DM on enrollment with the use of oral anti-hyperglycemic agents or any extended-release insulin and laboratory hemoglobin glycated (HbA1c) on enrollment was more than 6.4% or fasting blood glucose > 126 mg/dl and two hours postprandial blood glucose > 200 mg/dl.

The Al-Azhar University Medical Faculty Ethical Committee supported the study. Every one of the subjects gave their written information permission. Patients who were ineligible for inclusion in the trial were those who received a kidney transplant, were on dialysis due to end-stage renal disease, were allergic to contrast, had been exposed to contrast in the last week, were nephrotoxins, or refused to provide their consent.

All patients underwent a history, physical exam, laboratory tests [complete blood count (CBC), hematocrit, HbA1c, fasting blood sugar (FBS), renal function test (baseline creatinine, baseline eGFR, creatinine post 48h, eGFR post 48h), and biomarkers of cardiac function (creatine kinase-MB isoenzyme [CK-MB] and troponin I [CTNI]), 12-lead electrocardiogram, and coronary angiography.

The CMV/eGFR ratio was calculated by dividing the quantity of contrast media used during PCI by the patient's eGFR. A coronary angiography was performed via the femoral artery following standard protocols. All angiography procedures used the non-ionic, low-osmolar contrast agent Ultra-vist (Iopromide, 370 mg/ml). Follow-up for Major adverse cardiovascular events (MACEs), renal function (creatinine), stent thrombosis, recurrent MI, mortality, arrhythmia (atrial fibrillation (AF), ventricular fibrillation (VF), and ventricular tachycardia (VT), cardiogenic shock, stroke, and complications of bleeding.

Statistical analysis:

This statistical analysis was carried out by IBM Inc. of Chicago, IL, USA, using SPSS v26. We used the unpaired Student's t-test to compare the two groups' quantitative data, which was given as mean and standard deviation (SD). We used either the Chi-square test or Fisher's exact test to assess the qualitative variables, which were provided as percentages and frequencies, respectively. By calculating the area under the curve, the AUC provides a quantitative measure of a test's overall performance. There is statistical significance if the two-tailed P value is less than 0.05.

3. Results

Age, sex, weight, dyslipidemia, systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), Killip score, ejection fraction (EF), hemoglobin (Hb), hematocrit, stented vessels, quantity of contrast, and thrombolysis in myocardial infarction (TIMI) class did not differ substantially between the two groups. Group 1 had substantially greater levels of hypertension (HTN), chronic coronary syndromes (CCS), HbA1C, fasting blood sugar (FBS), baseline creatinine, creatinine post 48h, fluoroscopy time, procedure duration, radiation dosage, CMV/eGFR ratio, and CIN compared to group 2 (P = 0.023, 0.016, <0.001, 0.009, <0.001, <0.05, 0.013, and 0.001, respectively). Group 1 had substantially reduced rates of smoking, ST-T alterations, increased cardiac enzymes, acute coronary syndrome (ACS), baseline eGFR, eGFR after 48 hours, and number of stents compared to group 2 (P = 0.047, 0.019, 0.016 and 0.016, <0.001, 0.015, respectively). Table 1

Table 1. Patients characteristics, SBP, DBP, HR, Killip score, ST-T changes, cardiac enzymes, ACS, CCS, laboratory investigations, stented vessel, amount of contrast, number of stents, TIMI class, fluoroscopy time, procedure time and radiation dose and CMV / eGFR ratio and CIN

		GROUP 1 (N=100)	GROUP 2 (N=100)	P
AGE (YEARS)		62.74 ± 9.97	59.99 ± 10.86	0.064
WEIGHT (KG)		89.87 ± 9.71	90.46 ± 10.46	0.680
SEX	Male	65 (65%)	70 (70%)	0.450
	Female	35 (35%)	30 (30%)	
MEDICAL HISTORY				
HTN		63 (63%)	47 (47%)	0.023*
DYSLIPIDEMIA		85 (85%)	75 (75%)	0.077
SMOKING		40 (40%)	54 (54%)	0.047*
SBP (MMHG)		130.35 ± 22.45	130.2 ± 22.02	0.962
DBP (MMHG)		81.2 ± 12.89	80.4 ± 12.63	0.658
HR (BEATS/MIN)		74.07 ± 8.05	73.92 ± 12.59	0.920
KILLIP SCORE		2 (2%)	0 (0.0%)	-
ST-T CHANGES		41 (41.41%)	58 (58%)	0.019*
ELEVATED CARDIAC ENZYMES		41 (41%)	58 (58%)	0.016*
ACS		41 (41%)	58 (58%)	0.016*
CCS		59 (59%)	42 (42%)	0.016*
LABORATORY INVESTIGATIONS				
HB (MG/DL)		11.82 ± 1.22	12.17 ± 1.41	0.059
HEMATOCRIT (%)		36.63 ± 2.21	37.2 ± 2.53	0.092
HBA1C (%)		7.75 ± 1.41	5.22 ± 0.25	<0.001*
FBS (MG/DL)		144.06 ± 18.25	89.2 ± 6.34	<0.001*
BASELINE CREATININE (MG/DL)		1.05 ± 0.23	0.97 ± 0.2	0.009*

BASELINE EGFR (ML/MIN)		91.02 ± 26.21	106.5 ± 31.96	<0.001*
CREATININE POST 48H (MG/DL)		1.5 ± 0.66	1.22 ± 0.47	<0.001*
EGFR POST 48H (ML/MIN)		70.2 ± 27.74	88.21 ± 26.87	<0.001*
EF (%)		49.99 ± 10.74	50.47 ± 8.72	0.729
AMOUNT OF CONTRAST (ML)		122.45 ± 45.46	114.2 ± 42.58	0.187
NUMBER OF STENTS	1	41 (41%)	61 (61%)	0.015*
	2	47 (47%)	33 (33%)	
	3	12 (12%)	6 (6%)	
TIMI CLASS	II	8 (8%)	14 (14%)	0.175
	III	92 (92%)	86 (86%)	
FLUOROSCOPY TIME (MIN)		11.6 ± 6.64	9.13 ± 6.15	0.007*
PROCEDURE TIME (MIN)		18.62 ± 8.69	15.58 ± 8.3	0.012*
RADIATION DOSE (DAP (GYM^2)		1397.21 ± 737.52	1123.81 ± 693.43	0.008*
CMV / EGFR RATIO AND CIN				
CMV / EGFR RATIO		1.45 ± 0.66	1.22 ± 0.62	0.013*
CIN		35 (35%)	15 (15%)	0.001*

Data are displayed as mean ± SD or frequency (%). * Significant p value <0.05, HTN: hypertension, SBP: systolic blood pressure, DBP: diastolic blood pressure, HR: heart rate, ACS: acute coronary syndrome, CCS: chronic coronary syndromes, Hb: hemoglobin, HBA1C: hemoglobin glycated, FBS: fasting blood sugar, eGFR: the estimated glomerular filtration rate, EF: ejection fraction, TIMI: thrombolysis in myocardial infarction, CMV: contrast medium volume, CIN: contrast-induced nephropathy.

At a cut-off of >1.3, the CMV/eGFR ratio predicts CIN strongly (P < 0.001 and AUC = 0.767), with 72% sensitivity, 66.67% specificity, 41.9% PPV, and 87.7% NPV. Figure 1, Figure 2, Figure 3

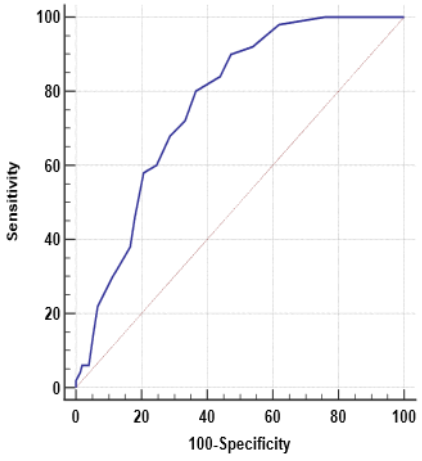

Figure 1. ROC curve of CMV / eGFR ratio in prediction of CIN

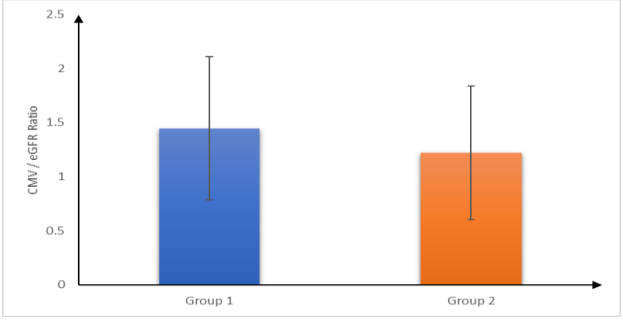

Figure 2. CMV / eGFR ratio of the studied group

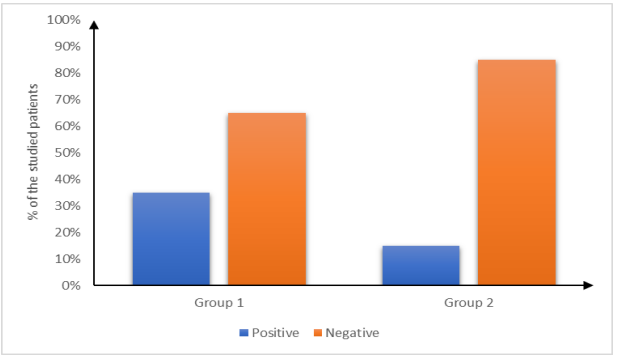

Figure 3. CIN of the studied groups

4. Discussion

When using contrast media for diagnostic and therapy purposes, the occurrence of clinical conditions, including diabetes, heart or kidney failure, and the patient's age, has been linked to the development of Contrast-Induced Nephropathy (CIN). The Contrast Media enhances image quality and has significantly altered radiologists' ability to differentiate between soft-tissue densities .[2] Iodinated CM injection causes CIN, a significant angiographic procedure consequence .[3]

According to the present study, Killip score was insignificantly different between both groups. ST-T changes and elevated cardiac enzymes were substantially less in Group One than in Group Two (P = 0.019 and 0.016, respectively). Kim et al.[8] showed that the Killip score did not change substantially between diabetes and non-diabetic groups, although cardiac enzymes were considerably lower in the diabetic Group compared to the non-diabetic Group.

According to the current data, ACS was considerably lower in group 1 compared to group 2 (P =0.016). Group 1 had substantially higher CCS, baseline creatinine, post-48-hour creatinine, baseline eGFR, and post-48-hour eGFR mean values than group 2. Hussain et al.[9] showed that the diabetes group had significantly higher blood creatinine levels 48 hours after the surgery compared to non-diabetic individuals (P < 0.001). In contrast, Kassaian et al.[10] reported that the creatinine level was insignificantly different between the diabetic and non-diabetic Groups.

Our data revealed that there was no significant difference in EF%, stented vessels, quantity of contrast, or TIMI class between diabetes and non-diabetic patients. The number of stents in Group I was substantially lower than in Group II (P=0.015). In agreement with our findings, Kassaian et al.[10] found that the EF% and number of stented arteries were not substantially different between diabetes and non-diabetic groups.

In terms of cardiac alterations, Chong et al.[11] found that the diabetes group had a considerably lower EF% and arteries stented than the non-diabetic Group.

Our results revealed that fluoroscopy duration, surgery time, and radiation dosage were considerably greater in groups 1 and 2 (P value < 0.05). Furthermore, group 1 and group 2 had a considerably larger correlation between fluoroscopy time and stent number (P value < 0.001). Our findings differed from those reported by Rao et al.[12], which showed there was no statistically significant difference in fluoroscopy or procedure time between the diabetic and non-diabetic groups. Furthermore, Lee et al.[13] found that the fluoroscopy and final procedure times were comparable in diabetes and non-diabetic groups undergoing PCI.

The study found significant differences between groups 1 and 2 in the connection between procedure duration, radiation dosage, CMV/eGFR ratio, and CIN (P < 0.001). Celik et al.[14] demonstrated that around 78 people experienced CI-AKI, whereas 519 patients did not acquire CI-AKI. T. Zaki et al.[15] reported that 58 individuals got CIN, whereas 192 did not. The correlation between negative CCS and CMV/eGFR ratio was substantially larger in group 1 compared to group 2 (P <0.001).

The CMV/eGFR ratio is a reliable predictor of CIN with statistical significance (P < 0.001) and an AUC of 0.767. It has a cut-off value of >1.3, achieving 72% sensitivity, 66.67% specificity, 41.9% positive predictive value (PPV), and 87.7% negative predictive value (NPV). Xue-chao and colleagues discovered that a CMV/eGFR ratio over 3.1 is a reliable indicator of contrast-induced nephropathy (CIN). A CMV/eGFR ratio greater than 3.1 shows 71% sensitivity and 70% specificity in detecting CIN. The AUC is 0.736 with a statistical significance of P=0.001. Celik et al.[16] discovered that a threshold of 2 for the CMV/eGFR ratio may forecast CI-AKI with 70% sensitivity and 78% specificity (AUC = 0.786, SE = 0.29, P < 0.001).

4. Conclusion

The CMV/eGFR ratio can predict CIN in diabetic and non-diabetic patients after PCI, and it is considerably greater in diabetic than non-diabetic groups.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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